



Shoalhaven Hydro Expansion Project

Origin Energy

State Significant Infrastructure Scoping Report

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1. Introduction

1.1 Background

Origin Energy Eraring Pty Ltd (a subsidiary of Origin Energy Limited) (collectively, Origin) is the current operator of the Shoalhaven Pumped Hydro Energy Storage Scheme (the existing scheme). The existing scheme is located in the New South Wales (NSW) Southern Highlands, approximately 150km south east of Sydney (refer to Figure 1.1). The existing scheme was commissioned in 1977 and currently has a generating capacity of 240MW.

The existing scheme was designed and constructed as a dual-purpose system, having both pumped storage generation capacity and inter-region water supply ability to move water from the Shoalhaven catchment to the Sydney drinking water catchment.

The existing scheme was designed in the late 1960's and Stage 1 Phase 1 was constructed in the 1970's including two generating / pumping units at Kangaroo Valley Power Station and two generating / pumping units at the Bendeela Power Station. Origin purchased the generation and pumping assets within the existing scheme from the State of NSW in 2013. Origin has since been progressively undertaking major overhauls to improve reliability of the existing scheme for future use out to at least 2070 under agreements with Water NSW. Water NSW retains ownership of the water storage and transfer infrastructure including the Fitzroy Falls canal, existing above ground and below ground pipelines, Bendeela Pondage and Lake Yarrunga.

The existing scheme was designed to allow for expansion and much of the required infrastructure needed for duplicating the scheme is already in place. Stage 1 Phase 2 involving the installation of an additional two units at the Kangaroo Valley Power Station was planned for the 1990's but was not completed. As a result, there is unconstructed expansion capacity at the site which was contemplated in the original Fitzroy Falls canal, switchyard located near the Kangaroo Valley Power Station and transmission lines, while the earthworks for duplicating the above ground pipeline on the plateau was also completed.

Origin now proposes to almost double the electricity generation capacity of the existing scheme with the Shoalhaven Hydro Expansion Project (the project), which will provide approximately an additional 235MW of pumped storage generation capacity. Origin has completed a Pre Feasibility Study and is now undertaking a Feasibility Study for the project which has and will include:

- Investment in a Feasibility Study approved by the Origin Investment Committee;
- The Australian Renewable Energy Agency (ARENA) has committed \$2 million to supporting the Feasibility Study under its Advancing Renewables Fund;
- Jacobs Group (Australia) Pty Limited (Jacobs) has been engaged as Owners Engineer and will undertake the Feasibility Study, including Environmental Assessment, with Origin;
- The NSW Government has declared the expansion project to be Critical State Significant Infrastructure (CSSI) to be assessed under a full merits based assessment under Division 5.2 of the Environmental Planning and Assessment Act (EP&A Act); and
- An application has been lodged for the approval of Geotechnical Investigations to allow these to proceed in advance of the approval of the overall Shoalhaven Hydro Expansion Project.

If feasible and approved, the project would operate within the parameters of the existing scheme water allocations such that maximum and minimum water levels and environmental flows within and from the Fitzroy Falls Reservoir and Lake Yarrunga would not change as a result of the project. Importantly, new dams or dam expansion do not form part of the required scope nor are installation of new transmission lines from the Kangaroo Valley substation.

Origin considers that the project will address New South Wales' essential economic, social and environmental needs by providing stable and rapidly dispatchable energy generation that will address intermittency risk and result in improved energy security.



Legend

- Points of interest
- Project location
- NPWS Reserve
- State Forest
- Indicative Shoalhaven Hydro Expansion Project Footprint

0 5 10 km
1:300,000 @ A4



Figure 1.1 | Shoalhaven Hydro Expansion Project Location

Data sources
DFSI - Spatial Services
Jacobs 2018

1.2 Project overview

Origin proposes to develop the Shoalhaven Hydro Expansion Project, being the construction and operation of a new pumped hydro power station on and under the land between the Fitzroy Falls Reservoir and Lake Yarrunga (the project). The project would draw on Origin's existing water allocations to pump water up from Lake Yarrunga consuming energy when it is in less demand. Energy would then be generated through the return of water from Fitzroy Falls Reservoir to Lake Yarrunga when demand for energy increases.

The project would involve almost doubling the electricity generation capacity of the existing scheme, providing an approximate additional 235MW of generation capacity.

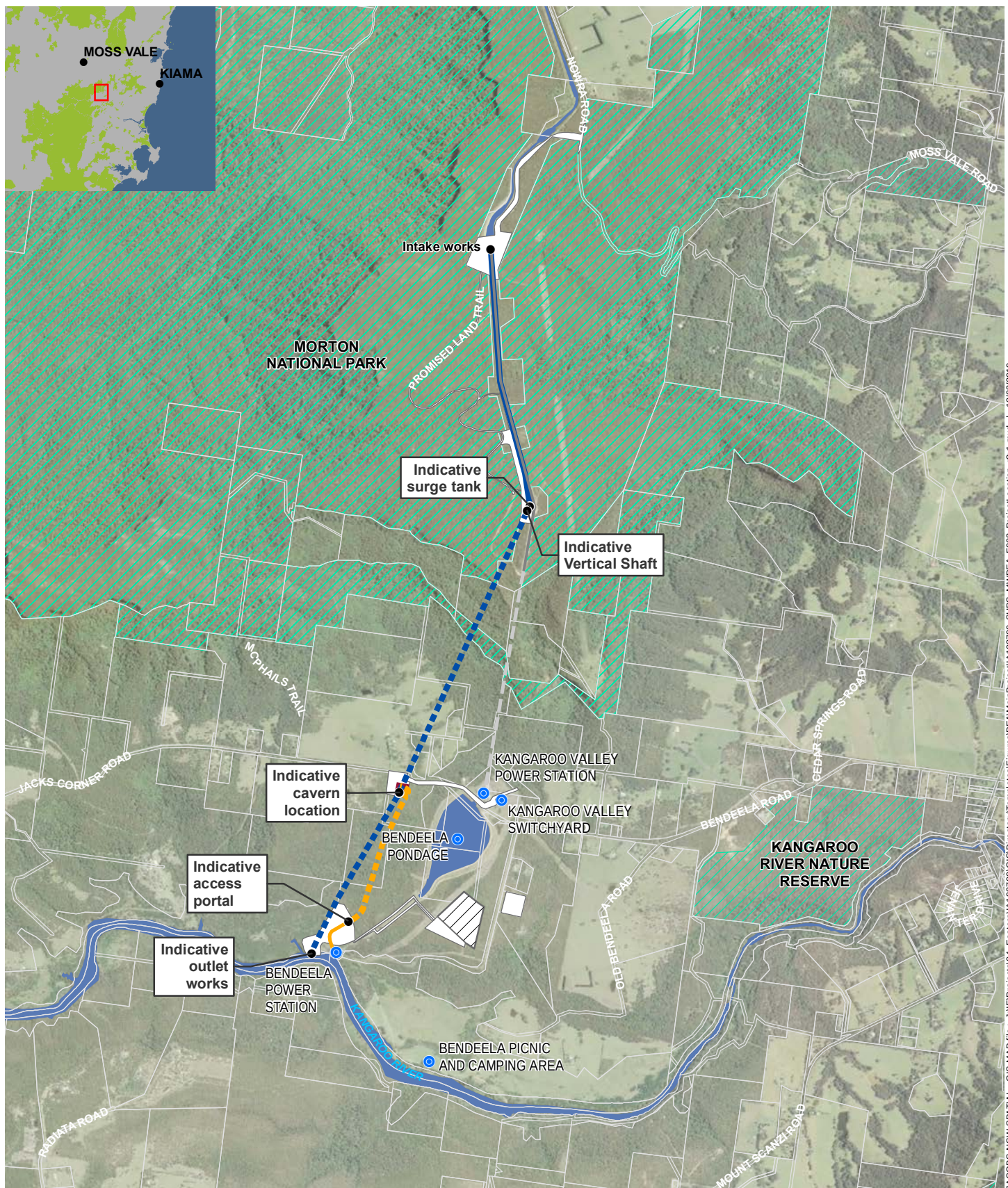
An indicative project layout based on the current reference design is provided in Figure 1.2 and consists of the construction and operation of:

- A surface pipeline from the existing Fitzroy Falls Canal control structure to a surge tank;
- Vertical shaft and headrace tunnel to an underground power station;
- An underground power station cavern housing a reversible generator and pump capable of supplying approximately 235 megawatts of hydroelectric power, including associated access tunnel and ventilation shaft, transformer and high voltage cable route to the existing Kangaroo Valley Power Station substation;
- A tailrace tunnel and intake /outlet structure in the vicinity of the existing Bendeela Power Station on Lake Yarrunga;
- A vehicular access tunnel to the underground power station from the vicinity of the existing Power Station; and
- Ancillary works which may include the carrying out of works to upgrade or construct access roads, spoil disposal sites, utilities infrastructure, construction compounds and construction power supply.

The project description would be refined in the Environmental Impact Statement (EIS) to reflect the current design status at the time.

The Shoalhaven Hydro Expansion Project is to be carried out in the *Wingecarribee* and *Shoalhaven Local Government Areas*. Access to the upper portion of the project on the plateau, for pipeline, surge tank and vertical shaft construction would be via the Promised Land Trail. The Promised Land Trail is accessed from Moss Vale Road and traverses both WaterNSW land and the Morton National Park and was constructed as part of the original scheme. Access to the lower portion of the Shoalhaven Hydro Expansion Project within Kangaroo Valley would be via Bendeela Road from Moss Vale Road in the vicinity of the townships of Kangaroo Valley and Barrengarry.

Importantly, the Shoalhaven Hydro Expansion Project essentially duplicates the existing scheme and as such, the project does not propose any new water storages or connections between waterbodies that have not already been utilised for the existing scheme. In addition, no transmission line augmentations are required to receive or distribute electricity from the existing Kangaroo Valley Power Station substation.



Legend

- Points of interest
- ▨ NPWS Reserve
- Indicative maximum disturbance area
- Indicative spoil management area
- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- ▨ Indicative tunnel alignment
- Indicative access tunnel
- Indicative access road

0 1 2 km
1:40,000 @ A4



Data sources

DFSI - Spatial Services
Jacobs 2018

Figure 1.3 | Shoalhaven Hydro Expansion project location and layout

1.3 Proponent

Origin is the proponent for the Shoalhaven Hydro Expansion Project and are the entity that own the existing Shoalhaven Scheme generating and pumping assets (Kangaroo Valley and Bendeela Power Stations). WaterNSW own the existing connection pipelines and tunnel between the reservoirs.

Origin is Australia's largest energy retailer by customer accounts, with 4.3 million customers across electricity, natural gas and LPG. Origin has an electricity generation capacity of more than 6,000MW, has over 6,000 employees, and has a market capitalisation of around \$16 billion (AUD).

Origin is deeply committed to leadership on climate change through the development and deployment of renewable energy. Origin has extensive experience in investing in renewable energy technologies and projects and offers a range of low carbon products to its diverse customer base. Origin is Australia's largest green energy retailer, providing Green Power to over 200,000 customers, installing solar energy on more than 80,000 homes and providing market leading solutions to the 360,000 of its customers with solar installed on their rooftops. Complementing the Solar photovoltaic (PV) business, Origin has two market leading battery storage products with world leading battery suppliers.

Origin has provided power purchase agreements to more than 1,200 MW of renewable energy projects throughout Australia over the last 3 years and has demonstrated a long-term commitment to the Renewable Energy Target through full compliance with the scheme for the 17 years since its inception. Origin was the world's first energy company to sign up to all seven initiatives under the global 'We Mean Business Coalition', joining a worldwide group of NGOs, signatory companies and institutional investors committed to leadership on climate change.

Origin is committed to "getting energy right for customers, the community and the planet". To ensure this commitment is delivered upon Origin has publicly stated three key areas of focus for the near term:

- Decarbonisation: efforts to tackle climate change continue to support strong growth in renewables and gas as a partner of renewables;
- Decentralisation: technological advancement enabling consumer empowerment and transition towards a decentralised energy future; and
- Digitisation: changing all aspects of operations and requiring an overhaul of business processes and interactions with customers.

To ensure that these objectives can be achieved, Origin acknowledges the importance of collaboration with the transmission and distribution network owners to ensure that the infrastructure that supports Origin's activities can adapt to the changes that these objectives present. The Shoalhaven Hydro Expansion Project is consistent with Origin's decarbonisation aims.

1.4 Planning and Assessment Process

The Shoalhaven Hydro Expansion Project, including geotechnical investigations, was declared to be State Significant Infrastructure and Critical State Significant Infrastructure (CSSI) by an amendment made to the *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP) on 14 December 2018.

Accordingly, Origin is lodging its application for approval for the project as CSSI under section 5.15 of the EP&A Act. A separate application for approval of the Geotechnical Investigations has been lodged.

1.5 Purpose of Report

The purpose of this report is to support an application for Secretary's Environmental Assessment Requirements (SEARs) under section 5.16 of the EP&A Act. Once issued, the SEARs will set out the matters to be addressed by Origin in the Environmental Impact Statement (EIS) to be prepared and submitted for the project under section 5.17 of the EP&A Act. This report documents the outcomes of the preliminary environmental risk analysis for the project and scopes the matters and impacts that are likely to be relevant to the project.

2. Project context

2.1 Location

The project site is located in the NSW Southern Highlands, approximately 150km south east of Sydney. The project would be predominantly located within the Shoalhaven Local Government Area with access and water for the scheme drawn from and returned to the existing Fitzroy Falls canal and reservoir located within the Wingecarribee Local Government Area (Refer to Figure 1.1).

The Project's surface works would be largely limited to land owned by WaterNSW associated with the existing Kangaroo Valley and Bendeela Power Stations and water transfer operations (Refer to Figure 2.1). WaterNSW land includes land either side of the existing surface pipeline and surge tank at the top of the plateau and land between Jacks Corner Road and Lake Yarrunga.

Access to the Fitzroy Falls Canal control structure, surface pipeline, surge tank and vertical shaft on the plateau during construction would be required via existing access tracks through the Morton National Park.

Below ground works for the high pressure headrace tunnel would be required beneath a 100 metre wide strip of Morton National Park located below the escarpment. These works would also be required beneath private freehold land located between the surge tank and Jacks Corner Road.

2.2 Surrounding land use

The major features of the area surrounding the project are illustrated in Figure 2.1 and include:

- The existing scheme;
- Morton National Park;
- Bendeela Recreation Area; and
- Rural landholdings and associated private dwellings.

2.2.1 The existing scheme

The existing Shoalhaven Scheme is jointly owned by WaterNSW and Origin Energy in a long-term arrangement running until 2070. The existing Shoalhaven Scheme comprises the Fitzroy Falls Reservoir, Fitzroy Falls Canal, Kangaroo Pipeline, Kangaroo Valley Power Station, Bendeela Pondage, Bendeela Pipeline, Bendeela Power Station, Tallowa Dam (Lake Yarrunga), Origin Energy owns and operates only the generating and pumping assets while WaterNSW owns the water related assets.

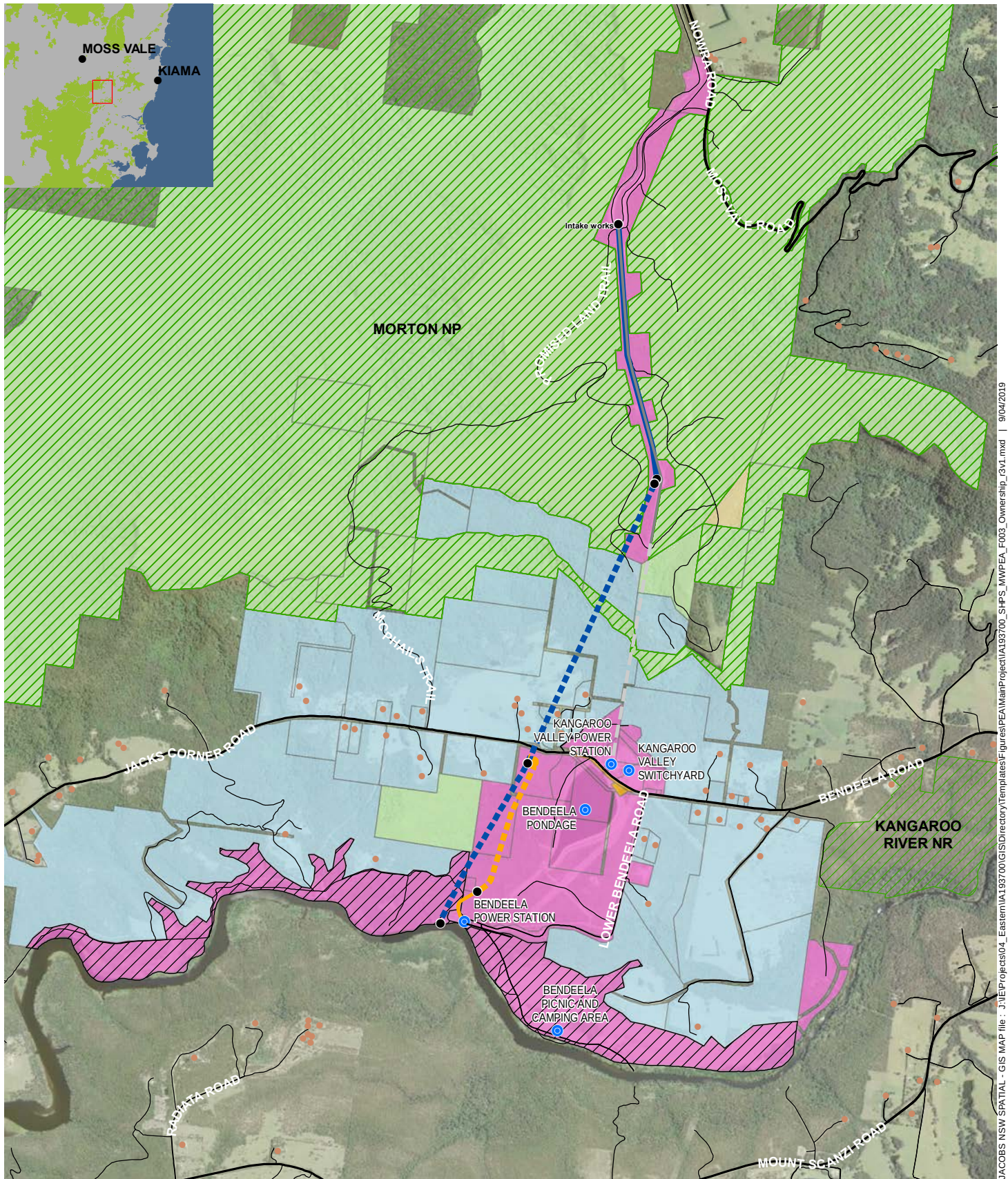
The original design and construction of the existing scheme allowed for future expansion through the provision of sufficient capacity in the station services such as high voltage transmission lines and the Fitzroy Falls Canal and canal interface structures (inlet gates and pipe head). Construction of the existing scheme also extended to much of the bulk earthworks required for the surface pipeline on the plateau being completed.

WaterNSW use the existing scheme to transfer water from the Shoalhaven catchment to the Sydney catchment to supplement the upper Nepean dams and Warragamba Dam and therefore the water supply of the Illawarra and Sydney water supply systems.

The total capacity of the existing scheme is 240 MW, across the following assets:

- Kangaroo Valley Power Station consisting of two 80 MW pump turbines, for a total of 160 MW of electricity generation capacity; and
- Bendeela Power Station consisting of two 40 MW pump turbines, for a total of 80 MW of electricity generation capacity.

The cumulative impacts of operating the project and existing scheme would be considered as part of the EIS.



Legend

- | | | |
|--------------------------------|------------------------------------|------------------------|
| ● Points of interest | — Indicative above ground pipeline | Land ownership |
| ● Private residences | — Indicative tunnel alignment | Private |
| — Existing KV tunnel alignment | — Indicative access tunnel | NSW Government (other) |
| — Existing scheme pipeline | — Indicative access road | Local Government |
| | NPWS Reserves | WaterNSW |
| | Shoalhaven Special Area | Crown land |

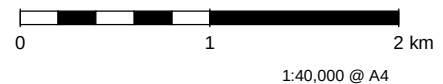


Figure 2.1 | Property landownership

Data sources
 DFSI - Spatial Services
 Jacobs 2018

2.2.2 Morton National Park

The Morton and Budawang National Parks together comprise an area of over 190,000 hectares on the eastern escarpment of the Southern Tablelands. The park stretches from Bundanoon in the north to southeast of Braidwood and covers a diverse, rugged and scenically magnificent landscape. The Morton National Park is managed in accordance with the *Morton and Budawang National Parks Plan of Management* (NSW NPWS, 2001). This document recognises the important landscape, geology, biodiversity, heritage and wilderness values of the Morton National Park. The document also recognises existing uses associated with water and electricity infrastructure.

The project would require access during construction and ongoing operation via short sections of existing access tracks established as part of the construction of the existing scheme. It would also involve the establishment of a tunnel deep below a small section of the National Park. No ongoing surface impacts to the National Park are anticipated as a result of the project.

2.2.3 Bendeela Recreation Area

The Bendeela Recreation Area is located on the northern bank of Lake Yarrunga directly to the east of the existing scheme. The Bendeela Recreation Area consists of a popular, serviced camp ground operated by WaterNSW on WaterNSW land. Access to the camp ground may be affected during construction but no ongoing impacts are anticipated.

2.2.4 Surrounding landholdings

There are several communities and townships within the zone of influence of the project. These include Barrengarry and Kangaroo Valley in the vicinity of the lower portion of the project and Fitzroy Falls, Wildes Meadow and Avoca in the vicinity of the existing Fitzroy Falls Reservoir.

Surrounding landholdings are rural in nature consisting of isolated dwellings to the east and west of the project and accessed off Bendeela Road and Jacks Corner Road. The project would require the construction of the headrace tunnel deep beneath private rural properties.

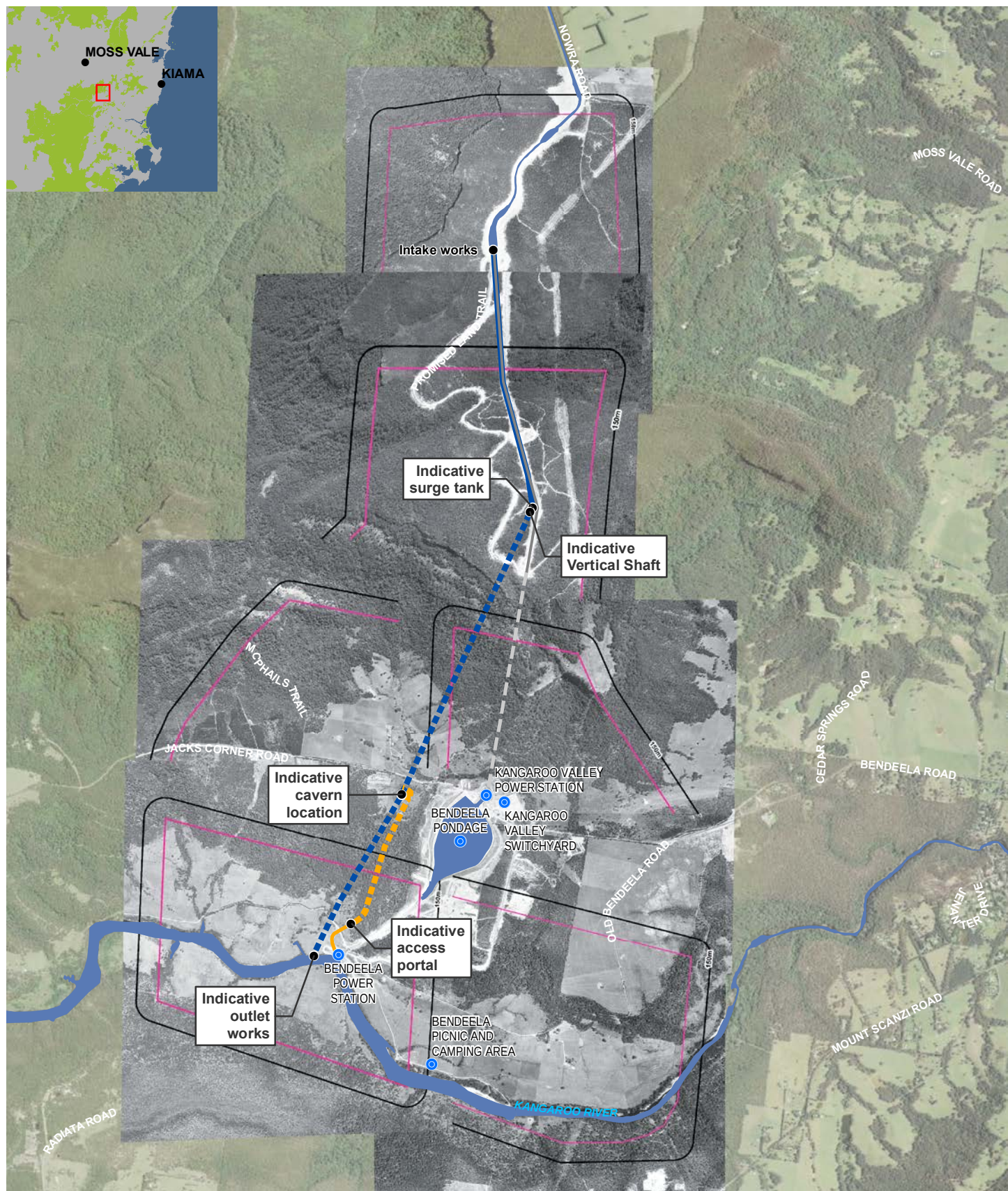
The Scots Collage Glengarry Campus is located approximately 500 m to the west of the proposed outlet works.

2.3 Existing Environment

2.3.1 Historic context

The main project features are located in close proximity to the existing scheme and generally in areas of prior disturbance as illustrated in Figure 2.2. Historical aerial photographs from 1974 and 1963 are provided in Appendix B illustrating historic disturbance and land use.

Despite this prior disturbance history, the project is located in an area of elevated environmental sensitivity. In particular, the project is located partly within the WaterNSW Shoalhaven Special Area catchment. The above ground pipeline, surge tank and vertical shaft is located within a narrow (80 – 300 m wide) strip of land excised from the Morton National Park associated with the existing scheme.



Legend

- Points of interest
- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Indicative access road

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Data sources

DFSI - Spatial Services
Jacobs 2019

Figure 2.2 | Historic context (1974)

3. Project Description

3.1 Overview

The project will increase the pumped hydro-electricity capacity of the existing scheme by approximately 235 MW. An indicative project layout based on the current reference design is provided in Figure 1.2 and an indicative cross section of the project is provided in Figure 3.1.

The project would share a common upper intake at the Fitzroy Falls Canal and discharge into Lake Yarrunga in close vicinity to the existing lower intake / outlet works of the Bendeela Power Station. The project would also include:

- A new underground pumped hydro station;
- Access and ventilation tunnels and underground and overground water pipelines;
- Surge tanks and intake and outlet structures; and
- Ancillary development which may include the upgrading or construction of access roads, utilities infrastructure and construction compounds.

For technical and practical reasons, there may be a requirement to reconsider the main elements of the project during the detailed design and construction phase. Potential variations may include:

- Repositioning of project components where justified on constructability, efficiency or cost and balancing environmental and social impacts;
- Altered construction methods (including spoil haulage, component delivery, use of cable crane, tunnelling methods etc) were justified based on minimisation of impact, construction duration and cost; and
- Total energy capacity due to improvements in technology.

It is desirable that flexibility is provided in the project description to allow the final design and specifications for the project to be determined based on selection of preferred technology and optimisation of layout to achieve the most economically, and environmentally and socially feasible development. The assessment of the project within the EIS would be based on the identified highest impact scenario of the project and using highest impact technology and project locations under consideration at the time of lodgement. This project description would be refined in the EIS to reflect the current design status at the time.

3.2 Operations

During operations, the project will convey water through a surface pipeline parallel to the existing pipeline from the existing intake works at the end of Fitzroy Falls Canal to a surge tank located adjacent to the existing surge tank. The conveyance will continue through a vertical shaft that will connect to a headrace tunnel. The headrace tunnel will then link to the pump-turbine in the new underground power station, through to the tailrace tunnel and finally discharge to the lower intake / outlet works at Lake Yarrunga.

An access tunnel and ventilation/ emergency exit/ services shaft will link to the underground power station. The grid connection will be via the existing switchyard located immediately east of the Kangaroo Valley Power Station.

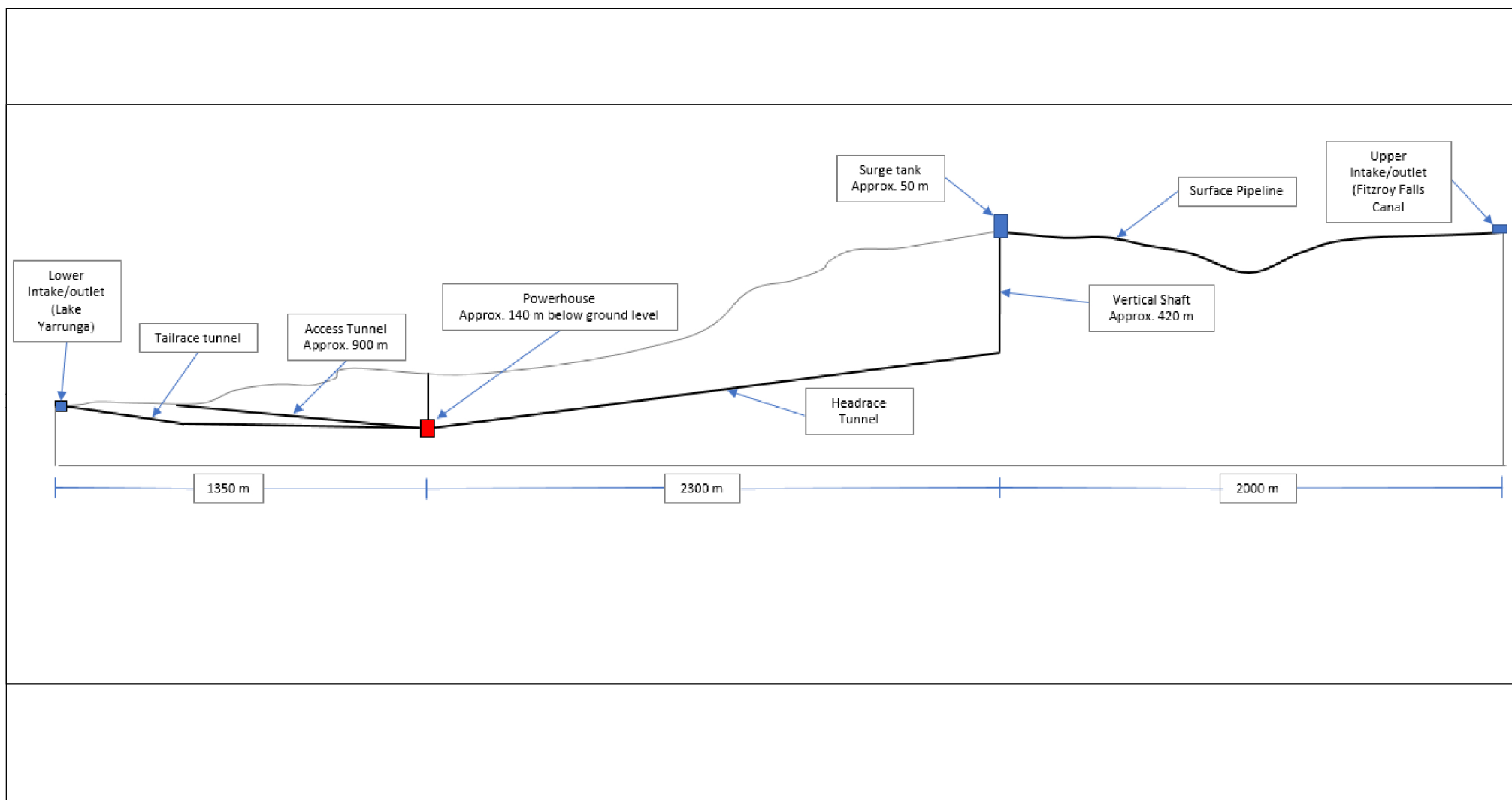


Figure 3.1 | Indicative Scheme Cross Section

Origin owns and operates a diverse generation portfolio, is a significant electricity retailer and currently operates a two-stage pumped hydro scheme directly adjacent to the project. Consequently, Origin could use the new scheme in multiple ways to best service the National Electricity Market (NEM). The project design is intended to provide opportunity to dispatch electricity at high cycle efficiencies while using the other operating assets to maintain flexibility to manage the electricity market dispatch requirements. It is expected that the project will be available to operate in pumping and generation cycles between major offline inspection services with high availability to respond to variations in grid energy supply and demand.

The project will be designed for unmanned operation and under normal operating conditions, operations and maintenance activities will be limited to routine operations surveillance or routine maintenance consistent with good international hydro power practices. The project will be designed for fully automatic remote control, start up and shutdown in all modes of operation from the Kangaroo Valley Power Station.

The project will use Origin's existing water allocation as per Water Access Licence 27432. It is noted that this water allocation is currently fully drawn by the existing scheme. As such, the concurrent operation of the project and existing scheme will result in the existing water allocation being drawn and returned over shorter cycles. While this will not change the maximum and minimum water levels in either Lake Yarrunga or Fitzroy Falls Reservoir, the rate at which water levels change will increase. The full implications in relation water level changes and localised flow rates in pumping and generation modes will be detailed in the EIS. The environmental and social consequences of these changes will also be assessed in the EIS.

3.3 Operational project components

Based on the current Reference Resign, the following key project elements are needed for the operation of the project:

- Above ground pipeline;
- Surge tank;
- Vertical shaft and headrace tunnel;
- Powerhouse cavern and generating unit;
- Transformer;
- Tailrace tunnel;
- Outlet works;
- Access tunnel; and
- Ancillary surface infrastructure.

3.3.1 Surface Pipeline

A surface pipeline will be used to convey water from the end of the Fitzroy Falls Canal to the vertical shaft. The pipeline will connect into the existing intake works via an existing connection portal (refer to Figure 3.2) and will occupy the constructed earthworks alignment adjacent to the existing above ground pipeline (refer to Figure 3.3).



Figure 3.2: Connection penetration into Fitzroy Falls canal for replicated pipeline.

Similar to the existing pipeline (refer to Figure 3.3), the proposed surface pipeline will be approximately 2 km in length and approximately 3.1 m in diameter. The pipe will be constructed of steel and elevated on footings with an anchor block located in the valley adjacent to Trimble Creek.



Figure 3.3: Prepared pipeline route for the surface pipeline

3.3.2 Surge tank

A surge tank with a diameter of approximately 15 m and approximate height of 48 m will be installed with top level elevation of 685 m above sea level (masl). The surge tank will be similar to the surge tank used in the existing scheme (refer to Figure 3.4) and be located approximately 40 m to the west. The surge tank is required to dissipate rapid pressure changes (“water hammer”) that result from starting and stopping water flows.



Figure 3.4: Existing surge tank

3.3.3 Vertical shaft and headrace tunnel

A vertical shaft approximately 3.5 m inner diameter (4.5 m tunnelled diameter) and 390 m deep will connect the surge tank and above ground pipeline to the underground headrace tunnel.

The headrace tunnel is anticipated to be 10% inclined and approximately 2.3 km in length from the generator cavern to the base of the vertical shaft. The vertical shaft and the headrace tunnel will have an approximate internal diameter of 3.5 m (5.5 m tunnelled diameter) and are anticipated to be steel lined.

3.3.4 Powerhouse cavern

The powerhouse and adjoining transformer cavern will be located approximately 180 m below ground just south of Jacks Corner Road and some 300 m west of the Bendeela Pondage. The powerhouse cavern would contain the following components:

- A pumped storage power plant consisting of a single Francis Reversible Turbine, capable of operating and switching between turbine and pump mode;
- Generator;
- Gantry crane and erection bay;
- Multipurpose ventilation, egress and services shaft; and
- Surface infrastructure including ventilation fans, fire water tanks and an 800 m long cable and services trench to connect to the Kangaroo Valley Power Station and Switchyard.

3.3.5 Tailrace

The tailrace tunnel will be a combination of steel and concrete-lined tunnel. The steel lined tunnel will connect from the powerhouse cavern and extend approximately 150 m. The concrete lined tunnel will extend approximately 1,250 m from the end of the steel lined tunnel to the inlet / outlet works at Lake Yarrunga. The tailrace tunnel will be approximately 5.5 m diameter (6.3 m tunnelled diameter).

3.3.6 Outlet/ Intake

The tailrace tunnel will connect to Lake Yarrunga via a new outlet/intake structure to be constructed following completion of other below ground structures. The outlet/intake structure would be some 80 m downstream (west) of the Bendeela Power Station and would be configured with a gate or bulkhead and trash-racks. The intake structure would be located approximately 60 m inland from the existing bank and connected to Lake Yarrunga via a channel to be cut through the rock bank.

The design of the inlet/outlet to Lake Yarrunga would allow operation of the project within the parameters of the existing water allocation, including minimum and maximum water levels.

3.3.7 Access tunnel

The powerhouse cavern will be accessed (for construction and operation) by an access tunnel approximately 1,100 m in length inclined at about 1 in 10. This tunnel is anticipated to have internal dimensions of up to 8 m in diameter and be configured to allow delivery vehicles to turn-around below ground. It is anticipated that the access tunnel would be connected to the Lower Bendeela Road west of the existing Bendeela Power Station.

3.3.8 Ancillary components

Various ancillary project components are required for the operation of the project. These are identified as including:

- Grid connection infrastructure to convey electricity to and from the generator to the existing Switch Yard at the Kangaroo Valley Power Station;
- Water, sewage, power, communications and other services, including as required connections to the Kangaroo Valley Power Station;
- An operations compound and buildings including fire tanks, ventilation plant, backup generator and access structures are proposed to be located set back from Jacks Corner Road above the powerhouse cavern; and
- Emergency access arrangements expected to include stairs to the operations building.

Details of ancillary operational components would be included in the EIS based on the outcomes of the feasibility study.

3.4 Construction

An overview of the key features of the Reference Design construction methodology for the project is outlined below. These methods are subject to change based on detailed design.

3.4.1 Surface pipeline and surge tank

The surface pipeline is likely to be constructed using a cable crane along the alignment with construction commencing from the southern to northern end finishing with connection to the upper intake control structure. The cable crane will service the transport of materials including the surge tank and vertical shaft. Construction methods will be deployed to minimise disturbance within the Moreton National Park to the extent possible.

3.4.2 Tunnel construction

Construction in the lower portion of the project will commence with concurrent works on the access tunnel and tailrace tunnel. A short permanent road would be constructed from the Bendeela Power Station to the access portal location where works will commence on construction of the portal followed by excavation of the tunnel. Bypass adits from the access tunnel around the cavern and to the crowns of the powerhouse and transformer cavern will be constructed to facilitate concurrent excavation and construction activities in the headrace and cavern locations.

Excavation and temporary support of the headrace tunnel including a works cuddy at the foot of the vertical shaft will precede surface raise bore and down reaming of the vertical shaft. Once temporary supports are in place, the shaft elbow will be installed enabling concurrent work fronts on the installation of permanent steel lining and grouting of the headrace and the vertical shaft. Vertical shaft lining and grouting will be undertaken from the surface.

The tailrace tunnel will commence at the lower intake works where a tunnel drive will commence from within an open surface excavation adjacent to Lake Yarrunga and approximately 15 m below full supply level and nominally 26 m below natural ground level. This will serve as an access location to commence tunnelling operations and ultimately form part of the intake channel and intake control structure foundations. A pillar of natural rock between Lake Yarrunga and the excavation will be maintained to act as natural coffer dam barrier during construction. The tailrace will be excavated a distance of approximately 380 m at 10% incline to gain adequate ground cover depth along the alignment before levelling out to a nominal 2.7% incline leading into the power house. Once tunnelling and lining operations are complete, the lower intake control structure will be installed. Removal and shoring up the natural rock barrier will be completed prior to wet commissioning.

Origin is engaging with specialist tunnelling contractors to determine the most efficient and effective method of tunnelling which may include the use of tunnel boring machine, road header and/ or drill and blast techniques.

3.4.3 Cavern construction

Excavation and support of the powerhouse and transformer cavern will be by conventional methods with bench excavation sequences commencing at the crown. The crowns will be accessed by temporary pilot tunnels excavated from the access tunnel. Once the crown excavation is complete the gantry crane will be installed to avoid constructing the gantry crane at height in the finished cavern and to support the movement of operatives and equipment between levels. Excavation will proceed downwards in lifts. Access to the next level of the cavern would be provided by the permanent access tunnel.

The ventilation and egress shaft will be constructed offset from the powerhouse cavern by raise bore and down reaming methods similar to the headrace shaft.

Construction of civil and structural works within the cavern will be by conventional means and phases commencing with draft tube installation progressively working up to the generator floor.

Electrical and mechanical fit out of the powerhouse cavern, transformer cavern and ventilation shaft will occur in stages co-ordinated with the civil and structural works sequence. The majority of plant and equipment will be delivered via the access tunnel.

3.4.4 Spoil management

The bulk of tunnel and cavern excavation spoil other than the tailrace tunnel spoil will be transported via the access tunnel and portal to allow the tailrace tunnel permanent lining to proceed without disruption. An extendable conveyor may be installed in the underground tunnels and exit via the access tunnel. Alternatively, trucks may be used. On exit the spoil will be transported by conveyor (approximately 1,500 m) to a dedicated spoil disposal location adjacent to Bendeela Pondage where it will be treated and managed to acceptable environmental standards. Tailrace spoil will be mucked out by truck and unloaded at a transition chute near the access tunnel. It will then be transported via conveyor to the spoil disposal area. An alternative option of trucking all the spoil to the spoil disposal area via the Lower Bendeela Road is also being considered.

All spoil from the vertical shaft and headrace excavations, other than minor volumes associated with the pilot hole boring, will be transported via the headrace and access tunnel to the spoil disposal area.

Minimal spoil is proposed to be generated on the plateau. The small volumes to be generated from the surface pipeline footings, surge tank foundations and trenching along a short section of pipeline immediately north of the surge tank are anticipated to be needed for levelling of construction and laydown areas, and access track maintenance. Surplus or unsuitable material would be transported via small trucks to the spoil disposal area adjacent to the Bendeela Pondage.

3.4.5 Surface infrastructure

Surface infrastructure including fire tanks, ventilation plant, structures and cable and service trenches to Kangaroo Valley Power Station will be constructed by conventional means.

3.4.6 Laydowns

All infrastructure for temporary works associated with the construction of the project will be limited to areas of previous disturbance to the extent possible. Due to the additional space constraints arising from the existing scheme, some additional clearing of rehabilitated areas and previously undisturbed areas is likely to be unavoidable. Notable temporary works include:

- Underground and construction works drainage infrastructure such as pumps, pipes, treatment plant and settling pond;
- Power and water supply;
- Conveyor systems;
- Cable-crane system footings;
- Temporary access roads and earthworks; and
- Construction laydown areas including batching plants.

3.4.7 Timing – hours and years

Construction is anticipated to take 36 to 42 months. The completion of construction is targeting mid 2023 to be available prior to announced closure of the Liddell Power Station. Completion at this time would be subject to outcomes of feasibility study and obtaining necessary approvals.

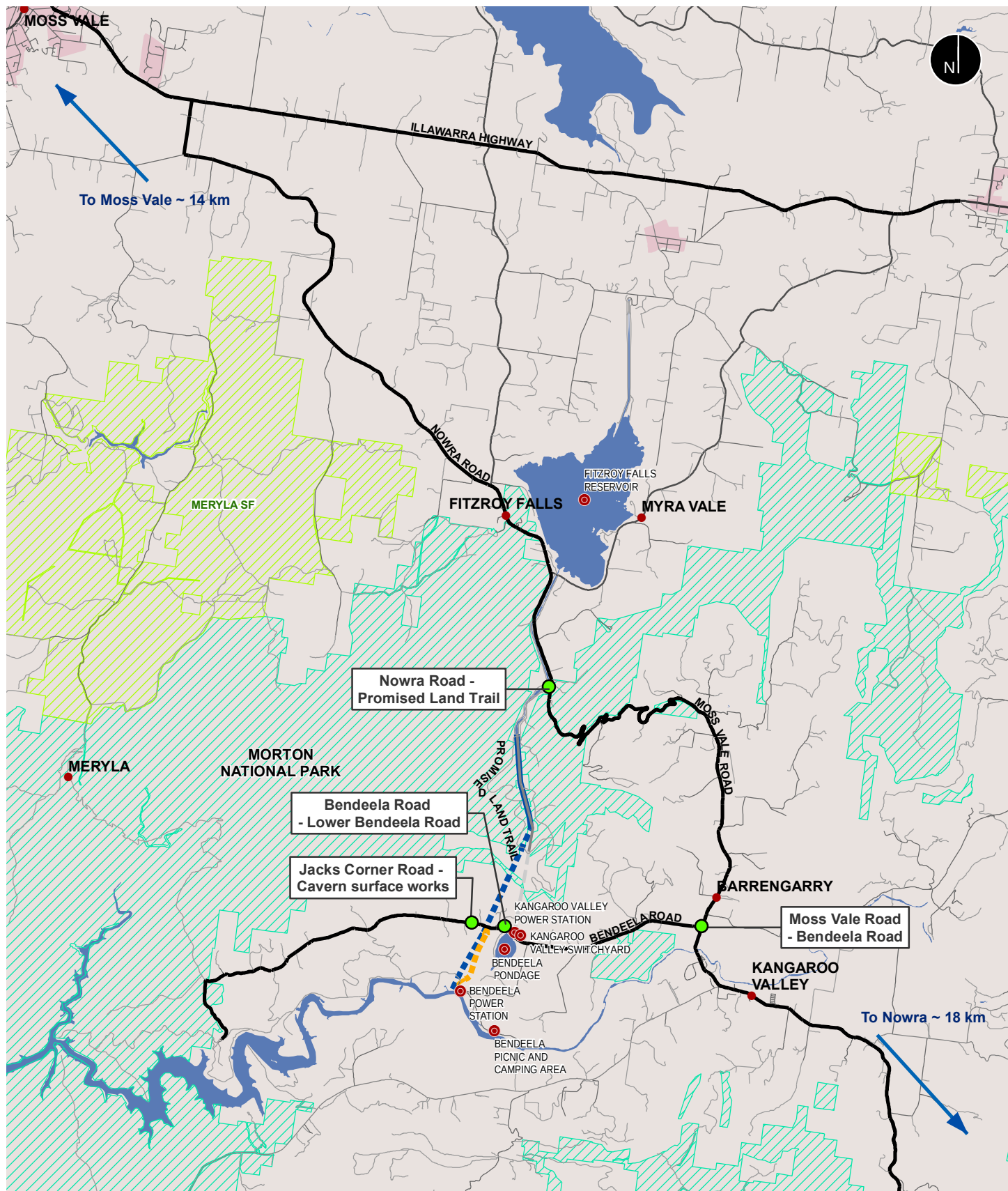
To achieve this timeframe, some construction, particularly below-ground works, would be required to be undertaken on a 24 hour per day and seven days per week basis. Other construction activities would generally be limited to standard construction hours.

3.4.8 Access and transport

Access to the plateau for pipeline and surge tank construction would be via the existing Promised Lands Trail off Moss Vale Road between Fitzroy Falls and Barrengarry. The Promised Lands Trail runs through WaterNSW land and the Morton National Park and was constructed to facilitate construction and operation of the existing scheme. Access to the Kangaroo Valley project components would be via Bendeela Road off Moss Vale Road between Shoalhaven and Barrengarry, and then via Jacks Corner Road and Lower Bendeela Road. The need for road intersection or access upgrades would be considered in the EIS and assessed where necessary. Indicative transport routes are illustrated in Figure 3.5.

3.4.9 Workforce

Workforce numbers will be estimated as part of the EIS in consultation with construction contractors. Workers would be sourced locally to the extent possible and be accommodated in existing facilities in the surrounding towns. Should a shortage of accommodation be identified associated with cumulative impacts of concurrent construction projects in the region, temporary worker accommodation would be considered at an appropriate location within the wider region where infrastructure is available to support the demands.



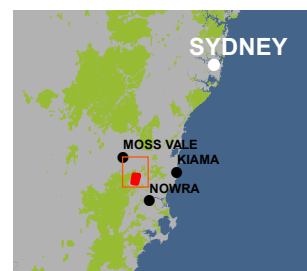
Legend

- Points of interest
- Key intersections
- NPWS Reserve
- State Forest
- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Indicative access road

Data sources

DFS - Spatial Services
Jacobs 2018

Figure 3.5 | Proposed transport routes



4. Strategic justification

4.1 Project Need

Since the maturation of intermittent renewable energy sources, Origin has sought to secure additional dispatchable energy generation capacity such that the decarbonisation of the Australian electricity system can be supported by the facilitation of renewables with increased storage capacity. This objective is aligned with the need identified by the *Independent Review into the Future Security of the National Electricity Market* (the Finkel Review), that the National Electricity Market requires stable, dispatchable generation to balance network requirements as renewable generation fluctuates depending on the predominate solar and wind resources available at the time.

Origin has undertaken a review of how this intermittency may be managed and concluded that the provision of additional, rapidly dispatchable energy storage via the project would provide a positive outcome. To that end Origin commissioned two pre-feasibility studies to explore the opportunities which may be present in expanding the existing scheme, which has ultimately led to the current project being pursued.

The selection of the Shoalhaven Hydro Expansion Project to meet this need is consistent with the NSW Energy Security Taskforce Final Report issued in December 2017, which recognised the significant benefits of pumped hydro energy storage as means of addressing New South Wales' critical energy, economic, social and environmental needs:

Pumped hydro energy storage (PHES) increasingly has potential in Australia to act as an effective electrical energy storage technology as an alternative to, or in conjunction with, batteries. PHES can contribute to both reliability and security of the grid, as it can provide the system security services associated with synchronous generation. Energy is stored when prices are low, such as from solar or wind energy, or overnight coal generation. During this time, water is pumped to the higher of two reservoirs and stored, then released when energy is needed.

The National Electricity Market is currently experiencing unprecedented change. The NSW Energy Security Taskforce Final Report identified the increasing penetration of intermittent renewable sources of electricity requires systems to respond more rapidly and flexibly, and that pumped hydro is likely to be needed to provide this capability.

The potential for unserved energy and not meeting current reliability standard is projected to increase in New South Wales and Victoria after Liddell Power Station closes (announced as 2022). In worst case scenarios this could lead to controlled load shedding or loss of supply in NSW. There is also a need for dispatchable energy generation projects to be able to respond to carbon reduction policies such as the NSW Renewable Energy Action Plan.

The Finkel Review identified that “Enhanced system planning will ensure that security is preserved, and costs managed, in each region as the generation mix evolves. Network planning will ensure that new renewable energy resource regions can be economically accessed”. The Council of Australian Governments (COAG) endorsed this recordation and the Australian Energy Market Operator (AEMO) subsequently prepared and released an Integrated System Plan for the NEM in July 2018 (AEMO, 2018). The Integrated System Plan (ISP) identifies that:

The ISP modelling identifies investment portfolios that can minimise total resource costs and the targeted transmission investment, as well as the development of selected REZs, necessary to achieve the lowest level of replacement investment costs.

To support an orderly transition, ISP analysis demonstrates that, based on projected cost, the least-cost transition plan is to retain existing resources for as long as they can be economically relied on. When these resources retire, the modelling shows that retiring coal plants can be most economically replaced with a portfolio of utility-scale renewable generation, storage, DER, flexible thermal capacity, and transmission.

Within the plan period, under AEMO's Neutral ISP planning scenario, the analysis projects the lowest cost replacement (based on forecasted costs) for this retiring capacity and energy will be a portfolio of resources, including solar (28GW), wind (10.5 GW) and storage (17 GW and 90 GWh), complemented by 500 MW of flexible gas plant and transmission investment. This portfolio in total can produce 90 TWh (net) of energy per annum, more than offsetting the energy lost from retiring coal fired generation.

The Shoalhaven Hydro Expansion Project would contribute to the storage requirements identified in the ISP and would only proceed if economically viable.

4.2 Commonwealth policy context

At the Paris Climate Conference COP21 (COP21) agreement was reached "to achieve a balance between anthropogenic (human induced) emissions by sources and removals by sinks of greenhouse in the second half of this century". Following COP21, international agreements were made to:

- Keep global warming well below 2.0 degrees Celsius, with an aspirational goal of 1.5 degrees Celsius (based on temperature pre-industrial levels);
- From 2018, countries are to submit revised emission reduction targets every 5 years, with the first being effective from 2020, and goals set to 2050;
- Define a pathway to improve transparency and disclosure of emissions; and
- Make provisions for financing the commitments beyond 2020.

On 10 November 2016, Australia ratified the Paris Agreement and the Doha Amendment to the Kyoto Protocol, representing the Australian Government commitment to action on climate change. The Government's current climate change plan includes:

- Reducing emissions by 5 per cent below 2000 levels by 2020;
- Reducing emissions by 26 to 28 per cent below 2005 levels by 2030;
- Doubling Australia's renewable energy capacity to be achieved in 2020;
- Helping improve energy productivity by 40 per cent by 2030;
- Ensuring big business and Australia's largest emitters do their part and continue to reduce emissions;
- Helping expand and protect green spaces and iconic places such as the Great Barrier Reef;
- Spurring businesses, communities, households and individuals into ongoing action to reduce emissions;
- Investing in innovation and clean technology to help capture the opportunities of a cleaner future; and
- Managing climate risks by building resilience in the community, economy and environment.

In 2017, the Government reviewed its climate change policies to ensure they remain effective in achieving Australia's 2030 target and Paris Agreement commitments. A final report was released on 19 December 2017 which generally indicated the government's policies were on course to meet Australia's international climate change commitments.

More recently, the Commonwealth government has announced a priority of reducing energy prices including the potential for underwriting firm generation. As part of its priority of making energy more reliable, the government has recognised that:

"Energy storage is an increasingly important part of our electricity system as it allows us to ensure energy is always available even when the sun and wind are not. Pumped hydro is the most common and most mature form of this energy storage".

The Shoalhaven Hydro Expansion Project is consistent with the Commonwealth government's climate change initiatives and facilitates the continued expansion of renewable energy generation by providing rapidly dispatchable energy storage capacity to respond to times of reduced renewable energy generation.

4.3 State policy context

The *NSW Climate Change Policy Framework* (OEH, 2016) represents the NSW Government position on responding to climate change and relates directly to how energy is generated and consumed in NSW. The *NSW Climate Change Policy Framework* aims to maximise the economic, social and environmental wellbeing of NSW in the context of a changing climate and current and emerging international and national policy settings and actions to address climate change. Its aspirational long-term objectives are to achieve net-zero emissions by 2050 and make NSW more resilient to a changing climate.

In September 2013, the NSW Government released the *NSW Renewable Energy Action Plan* to guide NSW's renewable energy development and to support the former national target of 20 per cent renewable energy by 2020. The NSW Government's vision is for a secure, reliable, affordable and clean energy future for the State. The *NSW Renewable Energy Action Plan* positions the State to increase energy from renewable sources at least cost to the energy customer and with maximum benefits to NSW.

The *NSW Renewable Energy Action Plan* strategy is to work closely with NSW communities and the renewable energy industry to increase renewable energy generation in NSW. The plan details three goals and 24 actions to most efficiently grow renewable energy generation in NSW:

- Attract renewable energy investment and projects;
- Build community support for renewable energy; and
- Attract and grow expertise in renewable energy technology.

The *NSW Government Submission to the Review of the Renewable Energy Target* (NSW Government, 2014) confirmed the NSW Government's commitment to promoting energy security through diversity, particularly through increasing the supply of energy from renewable sources. It identifies that having a diversity of supply can help to protect energy customers from price sensitivity associated with fuel inputs, such as gas prices.

In December 2018, responding to the AEMO (2018) Integrated System Plan, the State of NSW through the Department of Planning and Environment released the NSW Pumped Hydro Roadmap. This roadmap has the primary purpose of facilitating private investment in Pumped Hydro projects and notes that:

"An unprecedented transformation is underway across the entire energy supply chain and pumped hydro energy storage is expected to play a critical role in modernising the global energy system".

The Shoalhaven Hydro Expansion Project is acknowledged as undergoing feasibility assessment in the Roadmap and if developed would be entirely aligned with the roadmap as a private investment in the future stability and security of the NSW, and National, energy network.

4.4 Regional Policy

The Department of Planning and Environment's *South East and Tablelands Regional Plan 2036* includes a priority growth sector of renewable energy to diversify the economy. Specifically, the *South East and Tablelands Regional Plan 2036* includes Direction 6 to position the region as a hub of renewable energy excellence by promoting new opportunities for renewable energy industries and encouraging the co-location of renewable energy projects to maximise infrastructure, including corridors with access to the electricity network.

4.5 Shoalhaven Hydro Expansion Project Opportunity

The Shoalhaven Hydro Expansion Project opportunity has arisen from:

- The existing major water storage infrastructure at appropriate elevation differences;
- Existing scheme infrastructure appropriately sized and constructed in anticipation of future expansion;
- Existing water allocations that can accommodate the expansion without need for changes in current upper and lower storage minimum and maximum operating levels;

- Available capacity within the existing electricity transmission network; and
- Favourable market dynamics.

Subject to completion of the feasibility study, it is considered highly likely that based on these opportunities, the project can be constructed and operated in an economically feasible manner with long term environmental and social impacts largely consistent with those associated with the existing scheme.

4.6 Consideration of Options

The original design of the Shoalhaven Scheme allowed for the expansion of the Kangaroo Valley Power Station with provision of sufficient capacity for the station services, HV lines and structures, the Fitzroy Reservoir Canal and canal interface structures (inlet gates and pipe head). However other areas such as station structure, above ground pipeline and tunnels, turbines and pumps would need to be duplicated. Four augmentations options were identified in 2017 as part of the Kangaroo Valley Hydro Station Expansion, as follows:

- Option 1 – consists of duplicating the power station capacity with the addition of two 80 MW pump/turbine units. The Kangaroo pipeline, surge tank, shaft and tunnel would be duplicated, the power house building would be expanded and additional excavation and concrete works would be needed to house the new turbine/pump/generators. At the canal, a new outlet would be added while an additional inlet, bifurcation and discharge would be added at the power station for the new generating units.
- Option 2 – increasing the power station maximum generating capacity by 160 MW using a single reversible pump/turbine unit. The Kangaroo pipeline, surge tank, shaft and tunnel would be duplicated while additional deep excavation and concrete works would be needed to house the new turbine/pump/generator in the existing power house building. At the canal, a new outlet would be added while additional inlet and discharge would be added at the power station for the new generating unit.
- Option 3 – increasing the power station installed generating capacity by 80 MW by adding a single 80 MW unit. For this option, no change to the Kangaroo pipeline, surge tank, shaft or tunnel would be required. At the power station, a new inlet would be branched off the main pipeline upstream of the existing bifurcation. The discharge would be separate, with a draft tube leading into the pond, while excavation and concrete works to house the new unit would be required.
- Option 4 – increasing the power generating capacity with a single 200 MW to 300 MW generating unit to be located at the Bendeela Power Station by utilising the elevation difference between the Fitzroy Falls Reservoir and Lake Yarrunga. This option would include a new inlet/discharge from Fitzroy Canal, an extended new high pressure pipe/shaft/tunnel/penstock, a 200 MW or 300 MW turbine/ pump/ generator at Bendeela Power Station and discharge into Lake Yarrunga.

A further three options were considered in 2018, as follows:

- Option 5 – This option would involve a duplicate pipeline to a new surge tank adjacent to existing tank, shaft to high pressure tunnel, underground powerhouse with single 235 MW unit, access adit/cable tunnel from existing Kangaroo Valley switchyard area, tailrace to Lake Yarrunga with underground surge chamber adjacent to powerhouse and new intake/outlet on Lake Yarrunga downstream of existing Bendeela intake/outlet.
- Option 6 – This option would involve an underground shaft directly from the intake/outlet on Fitzroy Canal to a high pressure tunnel, underground powerhouse with single 235 MW unit, access adit/cable tunnel from existing Kangaroo Valley switchyard area, tailrace to Lake Yarrunga with underground surge chamber adjacent to powerhouse and new intake/outlet on Lake Yarrunga downstream of existing Bendeela intake/outlet.
- Option 7 - This option explored the potential for a 500 MW scheme largely independent from the existing scheme. An underground shaft would be required from a new intake/outlet on Fitzroy Falls Reservoir with a high pressure tunnel, underground powerhouse with two units, cable shaft to new

substation near Fitzroy Falls Reservoir and access adit to Carters Road, Barren Garry, tailrace to new intake/outlet on new 50 ha pondage on Barren Garry Creek.

Of these, Option 5 was identified as the technically least complex option, and most likely to succeed on the basis of constructability and environmental impacts as summarized in Table 4.1 below.

Table 4.1: Options consideration summary

Option	Nature of development	Description	MW	Value Drivers	Exclusion drivers
Option 1	Brown field	Expansion of original Scheme. 2 x 80MW at Kangaroo Valley Power Station. Duplicate pipeline and head race tunnel	160		Impact to existing operation. Limited mechanical plant options. Cost of multiple units.
Option 2	Brown field	1 x 160MW expansion at Kangaroo Valley Power Station	160		Impact to existing operation.
Option 3	Brown field	1 x 80MW serviced by existing pipeline and head race tunnel at Kangaroo Valley Power Station	80	Cost minimisation	Impact to existing operation. Exceedance of design flow rates in pipes and tunnels. Overall risk.
Option 4	Brown field	Bendeela capacity expansion utilising full head difference from Fitzroy canal. 1 x 200 - 300MW unit. Duplicate pipeline, new tunnel.	200	Improved cost benefit over options 1 and 2	Impact to existing operation.
Option 5	Greenfield	Duplicate pipeline. New tunnels and powerhouse. 1 x 235MW. Shaft at existing surge tank location	235	Lowest risk / benefit. Min disruption.	
Option 6	Greenfield	New tunnels and powerhouse. 1 x 235MW. Shaft at Fitzroy canal outlet works (No pipeline)	235		Cost of tunneling vs pipeline construction. Compared to Option 5.
Option 7	Greenfield (remote from existing scheme)	New independent scheme 2 x 250MW including lower pond. New offtake direct from the Fitzroy Falls reservoir.	500		Complexity of siting and operability limitations.

Based on the above, Option 5 was selected for additional optimisation based on key comparative criteria including:

- Hydraulic design;
- Geology / geomorphology;
- Construction complexity and constructability;
- Environment and permitting;
- Operability and life cycle cost;
- Capital cost;
- Accessibility;
- Schedule; and
- Safety.

To date, this optimisation has considered the following three variations to the general Option 5 arrangement as follows:

- The base case configuration with power house located at a depth of 330 m below ground level and below the vegetated lower portions of the escarpment with access to the cavern via tunnel from the Kangaroo Valley Power Station;
- Alternative configuration 1 positioning the power house cavern at the foot of the vertical shaft from the new surge tank with access via the Kangaroo Valley Power Station; and
- Alternative configuration 2 positioning the power house closer to Lake Yarrunga at a shallower depth and lower relative level compared to configuration 1 and the base case, and with access from the vicinity of Bendeela Power Station.

Alternative configuration 2 has been identified as the preferred option as it was identified as most favourable from hydraulic design, geology / geomorphology, environment and permitting, and accessibility perspectives. From an environmental perspective, alternative configuration 2 was identified as:

- Generating the least volume of spoil material;
- Requiring the least impact on higher quality vegetation;
- Requiring the lowest volume of works impact beneath private freehold land and Morton National Park; and
- Providing access to most favourable spoil locations in close vicinity to access tunnel adit.

4.7 Design refinement

Full details of the design for the project have yet to be completed. The Scoping Report is based on a current Reference Design which may be amended through the detailed design process. Construction methods may also vary subject to design refinements and the selection of the construction contractor.

The completion of the EIS is proposed to be based on the identified highest impact scenario of the project, using highest impact technology and project locations under consideration at the time of lodgement. This would allow consideration of reasonable worst case environmental impacts to allow flexibility in design and construction methodology.

5. Statutory framework

5.1 NSW Planning Framework

The *Environmental Planning and Assessment Act 1979* (EP&A Act) establishes the planning and approvals process in NSW. The EP&A Act provides for the making of Environmental Planning Instruments (EPIs) including Local Environmental Plans (LEPs) and State Environmental Planning Policies (SEPPs), which set out requirements for particular localities and/or particular types of development. The applicable EPIs and the Regulations made under the EP&A Act determine the relevant planning approval pathway and the associated environmental assessment requirements for proposed development activities.

5.1.1 Critical State Significant Infrastructure

Clause 16 of the State Environmental Planning Policy (State and Regional Development) 2011 (SRD SEPP) provides that:

Development specified in Schedule 5:

- (a) *may be carried out without development consent under Part 4 of the Act, and*
- (b) *is declared to be State significant infrastructure for the purposes of the Act if it is not otherwise so declared, and*
- (c) *is declared to be critical State significant infrastructure for the purposes of the Act.*

Schedule 5 of the SRD SEPP lists:

- (1) *Development for the purposes of the Shoalhaven Hydro Expansion Project.*
- (2) *The Shoalhaven Hydro Expansion Project includes the following:*
 - a. *exploratory geotechnical works for the design of the project,*
 - b. *A new underground pumped hydro station,*
 - c. *tunnels and underground and overground water pipelines,*
 - d. *surge tanks and intake and outlet structures,*
 - e. *the decommissioning of the underground pumped hydro power station and rehabilitation of the site.*
- (3) *Development that is ancillary to other development in this clause (including the upgrading or construction of access roads, utilities infrastructure, construction accommodation, construction compounds).*
- (4) *The development is to be carried out on land in Kangaroo Valley, Barrengarry and Fitzroy Falls.*
- (5) *In this clause, **development** does not include the carrying out of surveys, sampling, environmental investigations, archaeological excavations or other tests or investigations for the assessment of the project.*

Accordingly, the project is Critical SSI which requires approval under Division 5.2 of the EP&A Act and the NSW Minister for Planning is the determining authority.

Under Division 5.2, section 5.14:

- (1) *A person is not to carry out development that is State significant infrastructure unless the Minister has approved of the carrying out of the State significant infrastructure under this Division.*
- (2) *The person is to comply with any conditions to which such an approval is subject.*

Sections 5.15 to 5.19 outline the process to be followed before the Minister's approval may be given. This includes:

- The lodgement of an application for approval under section 5.15;
- The preparation of environmental assessment requirements under section 5.16;
- Environmental Assessment and public consultation under section 5.17;
- The preparation of a Planning Secretary's environmental assessment report under section 5.18; and
- The giving of approval by Minister to carry out project under section 5.19.

This Scoping Report has been prepared to support an application under section 5.15 and the generation of SEARs under section 5.16.

5.1.2 Application of other parts of EP&A Act

Under Division 5.2, Section 5.22 (Application of other provisions of Act):

“(1) Part 4 and Division 5.1 do not, except as provided by this Division, apply to or in respect of State significant infrastructure (including the declaration of the infrastructure as State significant infrastructure and any approval or other requirement under this Division for the infrastructure)”.

(2) Part 3 and environmental planning instruments do not apply to or in respect of State significant infrastructure, except that:

(a) they apply to the declaration of infrastructure as State significant infrastructure or as critical State significant infrastructure (and to the declaration of development that does not require consent), and

(b) they apply in so far as they relate to section 3.16, and for that purpose a reference in that section to enabling development to be carried out in accordance with an environmental planning instrument or in accordance with a consent granted under this Act is to be construed as a reference to enabling State significant infrastructure to be carried out in accordance with an approval granted under this Division.

Accordingly, SEPPs and the LEPs do not affect the permissibility or assessment process for the project.

In accordance with Section 5.23 of the EP&A Act, the following authorisations are not required for approved State Significant Infrastructure (and accordingly the provisions of any Act that prohibit an activity without such an authority do not apply):

- a permit under section 201, 205 or 219 of the *Fisheries Management Act 1994*;
- an approval under Part 4, or an excavation permit under section 139, of the *Heritage Act 1977*;
- an Aboriginal heritage impact permit under section 90 of the *National Parks and Wildlife Act 1974*;
- a bush fire safety authority under section 100B of the *Rural Fires Act 1997*;
- a water use approval under section 89, a water management work approval under section 90 or an activity approval (other than an aquifer interference approval) under section 91 of the *Water Management Act 2000*; and
- Division 8 of Part 6 of the *Heritage Act 1977* does not apply to prevent or interfere with the carrying out of approved State Significant Infrastructure.

Under Division 5.2, section 5.24 an authorisation of the following kind cannot be refused if it is necessary for carrying out approved State Significant Infrastructure and is to be substantially consistent with the approval under this Division:

- an aquaculture permit under section 144 of the *Fisheries Management Act 1994*;
- an approval under section 15 of the *Mine Subsidence Compensation Act 1961*;
- a mining lease under the *Mining Act 1992*;
- a production lease under the *Petroleum (Onshore) Act 1991*;

- an environment protection licence under Chapter 3 of the *Protection of the Environment Operations Act 1997* (for any of the purposes referred to in section 43 of that Act);
- a consent under section 138 of the *Roads Act 1993*; and
- a licence under the *Pipelines Act 1967*.

The need for additional authorisations and approvals would be confirmed in the EIS.

5.1.3 Water NSW Act 2014 and Regulation 2013

The Water NSW Act 2014 (Water NSW Act) and Water NSW Regulation 2013 (Water NSW Regulation) together establish WaterNSW and their functions and powers. Under the Water NSW Act, the principal objectives of WaterNSW are:

- (a) *to capture, store and release water in an efficient, effective, safe and financially responsible manner, and*
- (b) *to supply water in compliance with appropriate standards of quality, and*
- (c) *to ensure that declared catchment areas and water management works in such areas are managed and protected so as to promote water quality, the protection of public health and public safety, and the protection of the environment, and*
- (d) *to provide for the planning, design, modelling and construction of water storages and other water management works, and*
- (e) *to maintain and operate the works of WaterNSW efficiently and economically and in accordance with sound commercial principles.*

Part 4 of the Water NSW Act provides for the declaration of Catchment Areas, Special Areas and Controlled Areas. Shoalhaven Catchment Area is proclaimed as Schedule 2 land under the Water NSW Regulation. Section 52 of the Water NSW Act requires the preparation of a plan of management for special areas, which has been satisfied through the adoption of the *Special Areas Strategic Plan of Management 2015* (WaterNSW and Office of Environment & Heritage, 2015). Section 53 requires that, subject to the requirements of any other Act or any instrument under any other Act, no operations are to be undertaken by the joint sponsors, being WaterNSW and National Parks and Wildlife, in relation to the lands within the Special Area unless the operations are in accordance with the plan.

The *Special Areas Strategic Plan of Management 2015* (WaterNSW and Office of Environment & Heritage, 2015) establishes nine strategic management objectives:

- Pollutants are controlled so that impacts on water quality and natural and cultural values are minimised;
- Surface and groundwater sources and their interactions will be better understood so decisions are made that seek to minimise impacts on Special Area's hydrological integrity;
- Pests and weeds are controlled so that impacts on water quality and ecological integrity are minimised;
- Measures are in place to minimise the impacts of built assets within the Special Areas on water quality, ecological integrity and cultural values;
- Access to the Special Areas is controlled to protect water quality and ecological integrity while providing for appropriate visitor opportunities;
- Fire management within Special Areas maximises protection of life and property, and minimises impact on water quality and ecological integrity;
- Ecological integrity including threatened plant and animal species, endangered populations, endangered ecological communities, geodiversity and other natural values are maintained;
- Cultural heritage values are acknowledged and conserved, and community associations supported; and

- Management of Special Areas is supported by appropriate policy, planning and evaluation.

Third party projects approved under the EP&A Act do not need to be undertaken in accordance with the Plan of Management and are regulated separately. The Water NSW Regulation establishes additional controls on activities proposed to occur within declared Special Areas and Controlled Areas as described by the *Special Areas Strategic Plan of Management 2015* (WaterNSW and Office of Environment & Heritage, 2015) as follows:

- *“Prohibiting certain conduct and activities within the Special Areas unless the consent of WaterNSW is given. Asset and infrastructure work assessed and approved under the EP&A Act may allow an otherwise prohibited activity such as entering the area, the damaging of plants or the use of vehicles. WaterNSW consent is still required in these circumstances and WaterNSW may place additional conditions to this consent.*
- *Providing WaterNSW powers in relation to water pollution offences. In certain circumstances, WaterNSW can stop an activity if it believes it has the potential or is causing actual water pollution through the provision of verbal and written directions. WaterNSW can direct investigations, the provision of information and the undertaking of remediation activities. WaterNSW can issue Penalty Infringement Notices and undertake prosecutions. The joint sponsors will ensure their construction and maintenance activities and those of other parties operating within the Special Areas, will meet environmental planning requirements. The joint sponsors will conduct an active program of asset maintenance to maintain safety and operational effectiveness and to minimise the incidence of suspended solids in waterways”.*

Of most relevance to project, clause 9 of the Water NSW Regulations establishes that:

“A person does not commit an offence under this Part (other than an offence under this clause or under clause 18, 19 or 20) by reason of anything done with the consent of Water NSW”.

Under clause 10 WaterNSW may grant such a consent:

- (a) *by a sign or notice displayed on the land or part of the land to which the sign or notice relates, or*
- (b) *by written notification to a person (in the form of a licence, permit, approval or any other written form).*

To this end, WaterNSW has provided Origin with an access agreement in relation to the ongoing environmental investigations. An extension of this agreement to cover the proposed scope of the project is being progressed concurrently with the approval process. It is understood that such an agreement would constitute the consent of WaterNSW and, if undertaken in accordance with any conditions of the access agreement, the project would comply with the requirements of the Water NSW Act and Regulation.

5.1.4 National Parks and Wildlife Act 1974

The objects of the National Parks and Wildlife Act 1974 Act (NPW Act) are as follows:

- (a) *the conservation of nature, including, but not limited to, the conservation of:*
 - (i) *habitat, ecosystems and ecosystem processes, and*
 - (ii) *biological diversity at the community, species and genetic levels, and*
 - (iii) *landforms of significance, including geological features and processes, and*
 - (iv) *landscapes and natural features of significance including wilderness and wild rivers,*
- (b) *the conservation of objects, places or features (including biological diversity) of cultural value within the landscape, including, but not limited to:*
 - (i) *places, objects and features of significance to Aboriginal people, and*
 - (ii) *places of social value to the people of New South Wales, and*
 - (iii) *places of historic, architectural or scientific significance,*
- (c) *fostering public appreciation, understanding and enjoyment of nature and cultural heritage and their conservation,*

(d) providing for the management of land reserved under this Act in accordance with the management principles applicable for each type of reservation.

The Morton National Park is reserved under the NPW Act and the use of existing roads within the reserved lands is required to access the upper portion of the project. The need for improvements to existing roads within the National Park is to be confirmed as part of detailed design and construction planning.

Part 12 of the NPW Act allows for the granting of leases, licences, easements and rights of way for activities within reserved lands. Origin has agreed formal access arrangements for the use of existing access tracks through the Morton National Park with National Parks and Wildlife Services, and no additional approvals are understood to be necessary.

The Project would involve works within or under Morton National Park. Section 182(2)(a) of the NPW Act provides that:

(2) The following provisions shall apply to and in respect of the Park:

(a) the Authority may continue and complete surveys and investigations for determining the location of a dam for water supply purposes and of a reservoir and ancillary works in connection therewith including pipelines and power lines, situated wholly or partly within the Park,

(b) the site of the dam and of the reservoir and ancillary works shall be determined by agreement between the Minister and the Authority,

(c) where the site has been so determined, the Governor may, notwithstanding section 37, by notification published in the Gazette:

(i) revoke the reservation of the Park as to so much of the lands reserved as are within that site, and

(ii) declare those lands to be vested in the Authority,

and thereupon those lands shall vest in the Authority, and

(d) the Minister may, from time to time, grant to the Authority such easements and licences over lands within the Park for pipelines, power lines and other purposes as may be necessary for or in connection with the use and operation of the dam and reservoir and ancillary works.

While this section may have considered the future expansion of the existing scheme, the Authority for the purposes of the Act refers to the Sydney Catchment Authority (subsequently incorporated into WaterNSW). As such recourse to this section may not be available for the project.

Elements of the project, in particular the new underground headrace tunnel will require limited development work (entirely underground) within the Morton National Park. Part 12 of the NPW Act, prescribes the circumstances in which leases or licences may be granted. It is anticipated that a lease or licence would be a suitable tenure option for the headrace tunnel and that this would be progressed in parallel to the EIS.

Under Section 86 of the NPW Act it is an offence to harm or desecrate an Aboriginal object or Aboriginal place. Under the NPW Act harm to an object or place includes any act or omission that:

(a) destroys, defaces or damages the object or place, or

(b) in relation to an object—moves the object from the land on which it had been situated, or

(c) is specified by the regulations, or

(d) causes or permits the object or place to be harmed in a manner referred to in paragraph (a), (b) or (c), but does not include any act or omission that:

(e) desecrates the object or place, or

(f) is trivial or negligible, or

(g) is excluded from this definition by the regulations.

Clause 3A of the National Parks and Wildlife Regulations excludes the following from the definition of harm:

An act carried out in accordance with the Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW as published by the Department in the Gazette on 24 September 2010 is excluded from the definition of harm an object or place in section 5 (1) of the Act.

An assessment of the project would be carried out in accordance with this Code of Practice. Further, under Section 5.23 of the EP&A Act an Aboriginal heritage impact permit under section 90 of the NPW Act is not required for approved State Significant Infrastructure.

5.1.5 Heritage Act 1977

The *Heritage Act 1977* (Heritage Act) provides a number of mechanisms by which items and places of heritage significance may be protected. The Heritage Act is designed to protect both listed heritage items, such as standing structures and potential archaeological remains or relics.

The Heritage Council of NSW maintains the State Heritage Register (SHR). Only those items which are of State-level heritage significance in NSW are listed on the SHR. Listing on the SHR controls activities such as alteration, damage, demolition and development. Part 4 of the Heritage Act requires Heritage Council approval to be obtained for activities impacting on items listed on the SHR.

Part 6, Division 9 of the *Heritage Act 1977* protects archaeological 'relics' from being 'exposed, moved, damaged or destroyed' by the disturbance or excavation of land. This protection extends to the situation where a person has 'reasonable cause to suspect' that archaeological remains may be affected by the disturbance or excavation of the land. It applies to all land in NSW that is not included in the SHR. A 'relic' is defined by the Heritage Act 1977 as:

Any deposit, object of material evidence which relates to the settlement of the area that comprises NSW, not being Aboriginal settlement, and has local or state significance.

Section 139 of the Heritage Act requires any person who knows or has reasonable cause to suspect that their proposed works will expose or disturb a 'relic' to first obtain an Excavation Permit from the Heritage Council of NSW (pursuant to Section 140), unless there is an applicable exception (pursuant to Section 139(4)).

Under Division 5.2, section 5.23 of the EP&A Act, approval under Part 4, or an excavation permit under section 139 of the Heritage Act is not required for approved State Significant Infrastructure.

Section 146 of the Heritage Act 1977 requires any person who is aware or believes that they have discovered or located a relic must notify the Heritage Council of NSW providing details of the location and other information required.

5.1.6 Roads Act 1993

Under section 138 of the *Roads Act 1993* (NSW) the consent of the roads authority is required to:

- Erect a structure or carry out a work in, on or over a public road, or
- Dig up or disturb the surface of a public road, or
- Remove or interfere with a structure, work or tree on a public road, or
- Pump water into a public road from any land adjoining the road, or
- Connect a road (whether public or private) to a classified road.

Approval under the Roads Act would be required for any access upgrades that may be required to facilitate safe access to the Promised Lands Trail from Moss Vale Road.

5.1.7 Protection of the Environment Operations Act 1997

The principal legislation regulating pollution and waste management in NSW is the *Protection of the Environment Operations Act 1997* (POEO Act). Scheduled activities as listed in Schedule 1 of the POEO Act require an Environment Protection Licence. Under Clause 17 of Schedule 1, general electricity works, meaning the generation of electricity by means of electricity plant that, wherever situated, is based on, or uses, any energy source other than wind power or solar power and with capacity to generate more than 30 megawatts of electrical power is a scheduled activity requiring an Environmental Protection Licence. An Environmental Protection Licence will need to be obtained prior to the commencement of construction of the project and may also need to cover other potential ancillary activities.

The POEO Act also regulates pollution through the establishment of environmental protection offences under Chapter 5. Offences relating pollution of waters, air, noise and land and waste management are established and are required to be complied with in completing the project.

5.1.8 Biodiversity Conservation Act 2016

Under Section 1.7 of the EP&A Act, the EP&A Act has effect subject to the provisions of Part 7 of the *Biodiversity Conservation Act 2016*.

Part 7 of the Biodiversity Conservation Act 2016 (BC Act) requires that an application for State Significant Infrastructure approval under Division 5.2 of the EP&A Act be accompanied by a Biodiversity Development Assessment Report unless "the Secretary of the Department of Planning and the Chief Executive of the Office of Environment and Heritage" determine that the proposed development is not likely to have any significant impact on biodiversity values".

A Biodiversity Development Assessment Report in accordance with the BC Act will be developed as part of the EIS.

5.1.9 Fisheries management Act 1994

Under Section 1.7 of the EP&A Act, the EP&A Act has effect subject to the provisions Part 7A of the Fisheries Management Act 1994 that relate to the operation of this Act in connection with the aquatic environment.

The objects of Part 7A of the FM Act are as follows:

- (a) to conserve biological diversity of fish and marine vegetation and promote ecologically sustainable development and activities,
- (b) to prevent the extinction and promote the recovery of threatened species, populations and ecological communities of fish and marine vegetation,
- (c) to protect the critical habitat of those threatened species, populations and ecological communities that are endangered,
- (d) to eliminate or manage certain processes that threaten the survival or evolutionary development of threatened species, populations and ecological communities of fish and marine vegetation,
- (e) to ensure that the impact of any action affecting threatened species, populations and ecological communities of fish and marine vegetation is properly assessed,
- (f) to encourage the conservation of threatened species, populations and ecological communities of fish and marine vegetation by the adoption of measures involving co-operative management.

An assessment of impacts to threatened aquatic species, populations or ecological communities is required.

Under Division 5.2, section 5.23 of the EP&A Act, approval under the FM Act is not required for dredging or reclamation works or the blocking of fish passage. Further, under Section 5.23 of the EP&A Act Division 7 (Stop work orders) of Part 7A of the *Fisheries Management Act 1994*, cannot be made or given to stop or interfere with declared Critical State Significant Infrastructure.

5.2 Commonwealth Referral Requirements

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the primary Commonwealth legislation relating to the environment. Under Part 3 of the EPBC Act, approval from the Australian Minister for the Environment and Energy is required for a controlled action being an action that:

- Has, will have, or is likely to have a significant impact on a matter of national environmental significance;
- Is undertaken on Commonwealth land and has, will have, or is likely to have a significant impact on the environment;
- Is undertaken outside Commonwealth land and has, will have or is likely to have a significant impact on the environment of Commonwealth land; or
- Is undertaken by the Commonwealth and has, will have or is likely to have a significant impact on the environment.

A significant impact under the EPBC Act is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts. Matters of national environmental significance (MNES) include:

- World heritage properties;
- National heritage places;
- Wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed);
- Nationally threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas;
- The Great Barrier Reef Marine Park;
- Nuclear actions (including uranium mining); and
- A water resource, in relation to coal seam gas development and large coal mining development.

It is generally the responsibility of the proponent (or the land owner if owned by the Commonwealth) of a proposed action to determine whether the project, or action, has the potential to impact upon a MNES and constitute the need for a referral to the Commonwealth for determination. An action that is referred for consideration by the Australian Minister for the Environment and Energy cannot be undertaken until the outcome of the referral process is completed - either through the decision of the Minister that the action is not a controlled action or that the assessment and approval process has been completed.

The EPBC Act Protected Matters Search Tool was searched on 22 January 2019 for the area between Fitzroy Falls Canal and Lake Yarrunga with a 1 km buffer. The Protected Matters Search Tool search results are provided in Appendix D and summarised in Table 5 1.

Table 5 1: Protected Matters Search Tool results

EPBC Act Protected Matters Search Tool - 1 km buffer	
World Heritage Properties	None
National Heritage Places	None
Wetlands of International Importance	None
Great Barrier Reef Marine Park	None
Commonwealth Marine Area	None
Listed Threatened Ecological Communities	4
Listed Threatened Species	42
Listed Migratory Species	16
Other Matters Protected by the EPBC Act - 1 km buffer	
Commonwealth Land	None
Commonwealth Heritage Places	None
Listed Marine Species	21
Whales and Other Cetaceans	None
Critical Habitats	None
Commonwealth Reserves Tribunal	None
Commonwealth Reserves Marine	None

The search results indicate that Matters of National Environmental Significance within the immediate project area are limited to biodiversity. A broader search, using a 10 km buffer, has been undertaken associated with preliminary biodiversity assessment, consideration of likelihood of occurrence and biodiversity assessment survey planning.

There is insufficient information at this time to confirm whether or not a significant impact is likely to result from a project. When the Reference Design is confirmed, and environmental assessment adequately progressed, a referral of the project would be made. In the event that a significant impact is considered likely, an accredited assessment process will be sought under section 87(4) of the EPBC Act where the Commonwealth accredits the assessment process under Division 5.2 of the EP&A Act.

The EIS would assess the potential for impacts on MNES regardless of whether or not the project is deemed a controlled activity.

6. Stakeholder Engagement

Origin seeks to establish and maintain open and effective communication and relationships with the community of Shoalhaven and all impacted stakeholders. Origin's community engagement approach is based on meeting community expectations and being open and transparent about their operations in line with their values.

6.1 Stakeholder identification and approach

Origin has identified a wide range of agency and private stakeholders that are expected to have an interest in or be impacted by the Shoalhaven Hydro Expansion Project (refer to Table 6.1).

Table 6.1: Identified stakeholders

Category	Stakeholder
Government Agencies	WaterNSW Sydney Water NSW EPA Transport NSW NSW Department of Planning and Environment NSW Office of Environment and Heritage Department of Primary Industries – Land and Water National Parks and Wildlife Service TransGrid Commonwealth Department of Environment and Energy Elected Representatives – Federal and State
Council Administration	Shoalhaven City Council Wingecarribee Shire Council
Neighbours	Directly affected landowners Indirectly affected landowners
Native title claimants	South Coast People Native Title claimant group
Economic Development Groups	Kangaroo Valley Chamber of Tourism and Commerce Shoalhaven Heads Chamber of Commerce and Tourism
Local Businesses	Various - including equipment suppliers, tourism operators, plant hire, contractors, accommodation, food and others.
Schools	The Scots College Cambewarra Public School Burrawang Public School Avoca Public School
Recreation and Tourism	Southern Highlands Sailing Club Kangaroo Valley Safaris Kangaroo Valley Kayaks
Environmental Groups	Landcare Kangaroo Valley Environment Group Friends of the Brush Tailed Rock Wallaby
Media	Valley Voice ABC Daily Telegraph
Emergency Departments	NSW Rural Fire Service – Kangaroo Valley Rural Fire Brigade

	NSW State Emergency Services Health Police Ambulance
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Following the announcement of the Shoalhaven Hydro Expansion Project as Critical State Significant Infrastructure on 14 December 2018, Origin commenced the process of consulting with these identified stakeholders.

Origin will continue to proactively inform stakeholders ahead of any work associated with the project. Communication will provide stakeholders with information on the feasibility study and EIS in particular, including potential impacts and steps taken to mitigate impacts.

6.2 Consultation to date

Origin publicly announced its plan for the project on 29 October 2018 and established a project specific website available at:

<https://www.originenergy.com.au/about/who-we-are/what-we-do/generation/shoalhaven-proposed-expansion.html>

The website provides options for stakeholders to seek further information and connect with the project. Only one enquiry to date via the website has related to environmental and social concerns and this was to register interest in being more fully consulted. All other enquiries have related to future employment or supplier opportunities.

Following the announcement of the project and declaration of the project as CSSI, Origin has commenced proactive consultation with directly affected stakeholders. A record of consultation to date is provided in Table 6.2.

Table 6.2: Consultation summary

Stakeholder	Consultation summary
WaterNSW	Origin has an existing relationship with WaterNSW through the shared ownership of the existing scheme. Origin has been consulting with WaterNSW on a continuous basis since plans for the Shoalhaven Hydro Expansion Project first emerged. Consultation has included establishment of access agreements and the process of gaining WaterNSW support for the project. WaterNSW has provided written confirmation to Origin that it does not object to the project being lodged and appropriately assessed in a two-step process with the first step being the application for approval for the geotechnical investigations with the second step being the application for the full Shoalhaven Hydro Expansion Project. WaterNSW's support is subject to a thorough environmental assessment in accordance with the NSW <i>Environmental Planning and Assessment Act 1979</i> being undertaken, and to not conflict with WaterNSW's statutory objectives and functions. A project interface plan has been established with WaterNSW and consultation will continue and will address the security of tenure for the Shoalhaven Hydro Expansion Project. To date, WaterNSW requirements have focussed on safe and environmentally protective measures for access to their landholding.
National Parks and Wildlife Services	Origin has agreed formal access arrangements for the use of existing access track and retaining water quality objectives through the Morton National Park. Origin will continue to consult with National Parks and Wildlife Services. In responding to the Geotechnical Investigation Environmental Impact Statement the Office of Environment and Heritage, including National Parks and Wildlife Services branch, indicated that "It is anticipated that, prior to the more extensive period of access for the expansion project (which may involve physical works such as track widening, vegetation trimming on-park and the like), a licence for access under the National Parks & Wildlife Act 1974 will be issued".

Stakeholder	Consultation summary
Shoalhaven Council	Shoalhaven Council was presented with proposed expansion information during the pre feasibility stage in April 2018, and provided an update on the ARENA funding announcement and progression to Full Feasibility. In February 2019, Origin provided council executives and counsellors with an overview of the proposed expansion including the initial geotechnical investigations and overall Shoalhaven Hydro Expansion Project. In relation to the project Council raised the need for the broader community to be informed of the works and environmental management measures to be implemented. Council also advised Origin of a range of projects occurring in the Council area within the proposed project execution timeframe, which Origin will take into consideration in the EIS.
Wingecarribee Shire Council	Wingecarribee Council was presented with proposed expansion information during the pre feasibility stage in April 2018, and provided an update on the ARENA funding announcement and progression to Full Feasibility. Origin has offered to provide a further briefing and will continue to engage with Wingecarribee Council.
Surrounding landowners	Origin has provided a project overview to all but one landowner whose property would be involved. Attempts to contact the remaining landholder will continue. To date, consultation has included a range of direct approaches including calls and face to face meetings to provide project briefings and confirm ongoing communication arrangements. Concerns raised are presented in Section 6.4. Origin has commenced the process of engaging with surrounding land owners that may potentially be affected by the project.

6.3 Ongoing consultation

Following the lodgement of the application and request for SEARs, Origin consultation is expected to include a planning focus meeting with State and local government stakeholders, public information day(s) and ongoing consultation with neighbours and directly affected landowners.

The following community consultation is committed to in the preparation of the EIS:

- Advertising in local media regarding the project and how additional information can be obtained via the website link;
- Postal area mail-out to advice of project website and public information session details;
- Hosting of at least one public information session during the preparation of the EIS; and
- Continued direct engagement with involved property owners.

In addition to the proposed planning focus meeting, further consultation with agencies is expected to include:

- Liaison with RMS, Wingecarribee Shire Council and Shoalhaven Council regarding transport logistics and necessary intersection and road upgrades; and
- EIS outcome pre-lodgement briefings with key agencies stakeholders including WaterNSW, OEHL/NPWS, Council's, RMS and others where requested.

The ongoing consultation will be considered during the detailed assessment of the project and outcomes of consultation will be included in the EIS. The EIS would then be publicly displayed and the opportunity for stakeholder submissions will be available which would be considered in a Response to Submissions Report, including description of how submissions have been addressed.

6.4 Identified and anticipated stakeholder issues

Community consultation to date has raised the following concerns:

- Potential for property value to be adversely affected;
- Ventilation shafts and whether they will emit emissions and noise under normal circumstances or in an emergency;
- Noise and vibration during operations due to proximity to cavern location;

- Construction traffic impacts;
- Damage and remediation of land and property should access to land be required;
- Whether other options were considered;
- Impacts to mobile phone and radio reception; and
- Electro magnetic fields.

In addition to concerns already raised, the following stakeholder concerns are anticipated due to the project location and nature of the project:

- Social and amenity impacts during construction including impacts on visitor economy, workforce accommodation and transport, traffic, noise and vibration and ventilation shafts and air quality impacts;
- Construction impacts to biodiversity, heritage, water quality and scenic character;
- Operational impacts on recreational use of Fitzroy Falls Reservoir and Lake Yarrunga, water levels and water quality;
- Operational impacts on rural and scenic character of the area as a result of additional above ground infrastructure.

These issues and any others raised through ongoing consultation would be considered in the EIS and relevant supporting specialist studies.

6.5 Aboriginal stakeholder consultation

For the Shoalhaven Hydro Expansion Project, Aboriginal Community Stage 1 Consultation is being undertaken in accordance with Section 4.1 of the *Aboriginal cultural heritage consultation requirements for Proponents (DECCW 2010)*. Consultation commenced with an agency and stakeholder mailout and phone conversations on 21 December 2018. An advertisement with project details appeared in the Koorie Mail and the South Coast Register on 16 January 2019 and included an invitation for Aboriginal people and Aboriginal groups, who hold cultural knowledge relevant to determining the significance of Aboriginal objects and places in the project area, to register an interest in a process of community consultation. Written correspondence with relevant agencies requesting names and contact details of Aboriginal people who may hold cultural knowledge relevant to determining the significance of relevant Aboriginal objects and/or places has been undertaken with responses so far received from the South East Local Land Services and the Illawarra Local Aboriginal Land Council. Potential cultural knowledge holders identified by these agencies were contacted on 6 February 2019. Registered Aboriginal Stakeholders have been appointed for the project and the process of agreeing survey methodology has commenced.

The South Coast People Native Title claimant group have an existing claim registered on 21 January 2018 which encompasses the project area. A telephone conversation with NTSCORP on 16 January 2019 to establish a communication protocol has been recorded in the Aboriginal consultation log.

7. Consideration of Environmental Impacts

7.1 Issue Identification

The likely environmental consequences of the project requiring assessment were identified through a series of risk review workshops involving input from people with a combination of pumped-hydro design, engineering, construction, operations and environmental assessment experience. The issue identification process and scoping of environmental impacts has involved:

- Consideration of construction and operational stages of development;
- Desktop review of relevant databases, historical aerial photography, reports associated with the existing scheme and available background data;
- Environmental specialist site walkover; and
- Outcomes of stakeholder consultation to date.

Key impact mechanisms identified for the project include:

- Tunnelling and cavern excavation and implications for groundwater drawdown, water management, spoil generation and land tenure;
- Spoil management, including emplacement location and implications for hydrology, acid generation potential and land sterilisation;
- Direct disturbance of land associated with construction of surface infrastructure and spoil disposal and implications for biodiversity, heritage, scenic character and water quality;
- Traffic and access impacts associated with construction activities, staff movements, material deliveries and spoil management;
- Water management during construction and operation including erosion and sedimentation management, spoil disposal, tunnel and cavern excavation dewatering, and operational water transfers with implications for water quality, water levels and water availability in Fitzroy Falls Reservoir and Lake Yarrunga.
- Construction activities with implication for amenity values through noise and vibration, light spill, dust, traffic generation and flow-on effects for recreational values and the visitor economy.

Further detail of the existing environment, impact mechanisms and proposed assessment methods is provided in the sections that follow.

7.2 Soils and Geology

7.2.1 Existing environment

The geology of the study area is varied across distance and depth. The surface geology of the lower valley in the southern extent of the study area is comprised of the Broughton formation, while the elevated plateau is chiefly comprised of the Hawkesbury Sandstone formation. The Broughton formation is largely characterised as sandstone, siltstone and mudstone, and was deposited in the Permian Period (252 to 299 million years old) (Geoscience Australia, 2018). The Hawkesbury Sandstone formation is characterised as quartz-lithic to quartz-rich sandstone with conglomerate, mudstone and siltstone, and was deposited in the Triassic Period (201 to 252 million years old) (Geoscience Australia, 2018). Table 7.1 provides further details about the underlying geological units within the study area.

Table 7.1: Geological Sequence in the Study Area

Geological Unit	Elevation (RL m)	Thickness (m)	Typical Description	Deposition Environment	Indicative Acid generation
Hawkesbury Sandstone	650 to 560	90	Medium to coarse grained, mostly massive and hard quartz – sandstone. A few lenses of shale and conglomerate. Cliff forming.	Braided fluvial system.	Low
Narrabeen Group	560 to 545	15	Alternating beds of lithic to feldspathic sandstone, shaly siltstone and claystone.	Deltaic-lagoonal floodplain.	Moderate
Illawarra Coal Measures	545 to 520	25	Alternating beds of quartz and lithic sandstone, siltstone, shale and claystone with coal seams.	Transitional Delta.	High
Broughton Formation	520 to 440	80	Grey-green, lithic to tuffaceous sandstone with thin beds of shale and claystone.	Fluvial,-deltaic floodplain backswamp.	Moderate
Budgong Sandstone	440 to 375	65	Medium to coarse grained, locally silty quartz-sandstone. Cliff forming. (Volcanic detritus).	Shallow marine to shelf.	Low
Berry Siltstone	375 to 170	205	Black to grey siltstone, ranging to silty sandstone.	Shallow marine to shelf.	High
Nowra Sandstone	170 to 130	40	Medium to coarse grained, massive quartz-sandstone.	Shallow marine to shelf (long shore drift).	Low
Wandrawandian Siltstone	130 to 30	100	Black to grey siltstone and sandy siltstone, commonly with pebbles.	Shallow marine to shelf.	High
Snapper Point Formation (Upper Unit of Conjola FM)	30 to -40	Inferred 70	Interbedded quartz-sandstone, siltstone and conglomerate.	Shallow marine to fluvial coastal plain.	Moderate
Yarrunga Coal Measures	-40 to -80	Inferred 15-40	Interbedded fine-grained sandstone, typically carbonaceous siltstone and shale, and thin coal seams and conglomeratic beds locally. Plant debris is common in the fine-grained lithologies.	Shallow marine to fluvial coastal plain.	
Devonian Base Rock	-55 to -80	unknown	Quartzite, white, with thin beds, lenses and blebs of green siltstone or claystone, highly deformed.		

A number of geological units within the study area have a moderate to high potential for generating acid rock. These include the Snapper Point Formation, Wandrawandian Siltstone and Berry Siltstone.

Soil profiles taken from the elevated plateau near the Kangaroo Pipeline indicated moist, yellowish brown soils with a loamy sand to sandy loam texture (OEH, 2018). Soil profiles measured on the slope near Bendeela Road indicated moist, black soils with a sandy loam texture (OEH, 2018).

7.2.2 Issues for consideration

The understanding of local geology is essential for the design and constructability considerations of the project. The project will involve tunnelling and the excavation of a cavern and as such the rock material properties also need to be understood from a material management perspective. The project is expected to produce between

180,000 to 200,000 cubic metres of spoil material from tunnelling works, including some sourced from geological units with medium to high potential for generating acid rock. Assuming a bulking factor of 40% (as the material is expected to be largely the composition of a coarse gravel), this could result in a loose excavated volume of approximately 250,000 to 280,000 cubic metres. Investigations into construction re-use opportunities and develop mitigation measures for the treatment and disposal of spoil material are required and will be conducted as part of the EIS.

The project would also involve ground disturbance for the construction of the new pipeline and surge tank on the plateau and the various surface infrastructure associated with the below ground tunnels, cavern, spoil handling and disposal and access portal. The soil profile would be considered in the development of drainage and erosion and sediment control structures as described in Section 7.3.

7.2.3 Method of assessment

Rock material encountered during geotechnical drilling will be tested to reveal the estimated volume of material and potential for acid generation. Results of this analysis will subsequently be incorporated into the design process and a treatment plan will be formulated. The outcomes of this study would be presented in the EIS.

7.3 Water – Hydrology

7.3.1 Existing environment

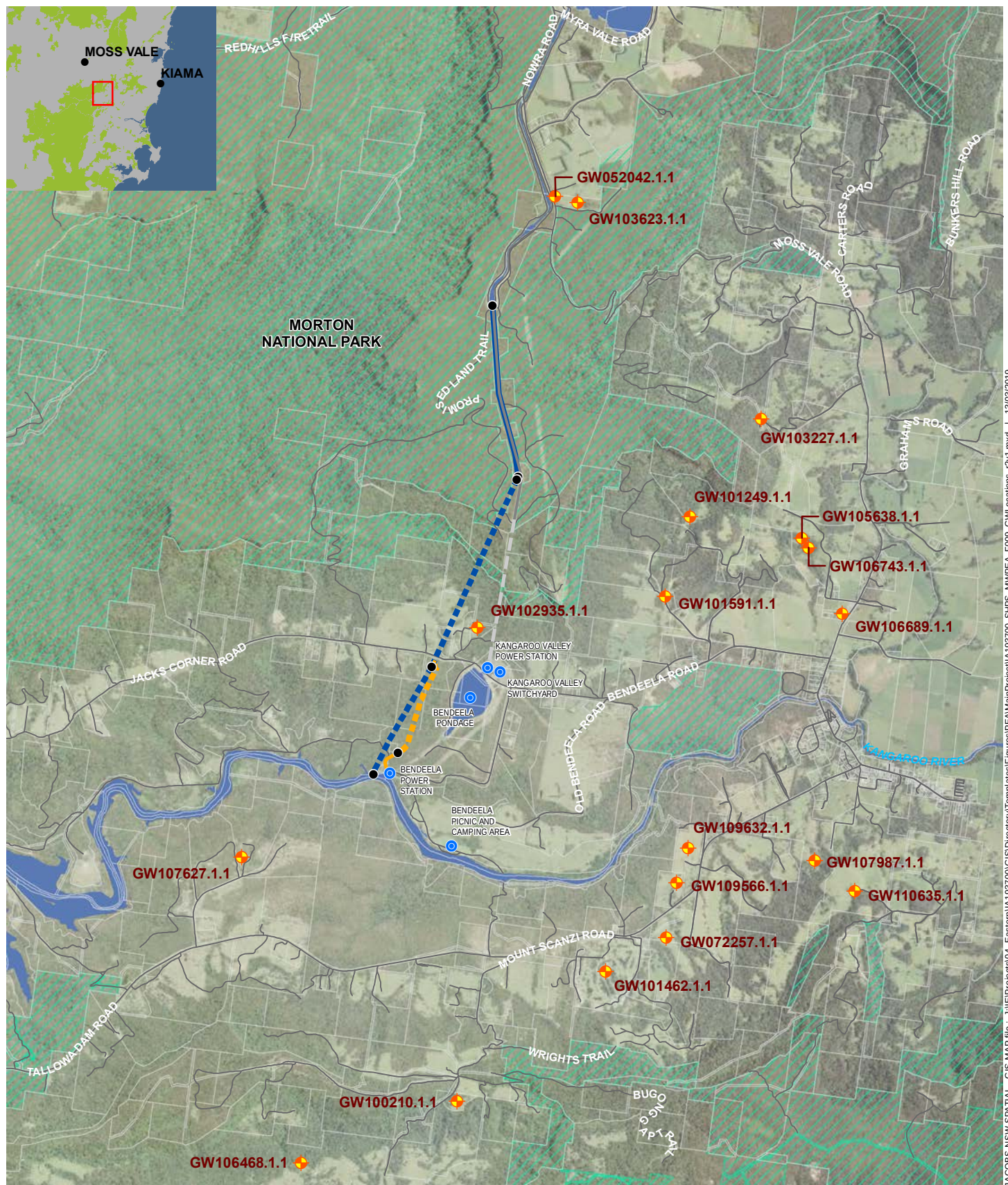
Ground Water

The study area is located within the *Greater Metropolitan Region Groundwater Sources (Sydney Basin South) Management area*. The topography of the proposed study area varies between 640 MASL to 50 MASL.

Limited groundwater information is available for the study area. The Water NSW groundwater bore database search within 5 km from the centre of the project indicated presence of 18 bores (WaterNSW, 2018c). The bores are mainly licenced for domestic and stock watering use with the exception of one bore, which is licenced for irrigation.

The groundwater elevation was recorded in 10 out of 18 bores. This varies between 6 m below ground level (bgl) to 60 m bgl and is mainly found within the fractured rock aquifer (sandstone and siltstone). The yield of this aquifer is recorded in 12 out of 18 wells. The recorded yield of the aquifer in seven wells is generally low (less than one litre per second). The recorded yield for the remaining five wells is moderate to high (1.5 to four litres per second in three wells and 20 to 26 litres per second in two wells). However, this yield information is likely to be related to airlift yield and unlikely to be sustainable yield of the aquifer.

Kangaroo River is located within a 5 km radius of the project and is identified as low to moderate potential aquatic groundwater dependant ecosystem (GDE) from national assessment (BOM, 2018b). Three low potential aquatic GDEs (wetland ecosystem) from national assessment are also identified within approximately 1,500 m from the proposed vertical shaft location, south of Fitzroy Falls reservoir. Low to high potential terrestrial GDEs are identified within a 5 km radius of the project from regional study. Aquatic spring GDEs are also identified within a 5 km radius of the project.



Legend

- Points of interest
- Indicative above-ground infrastructure
- Groundwater asset
- NPWS Reserve
- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Indicative access road

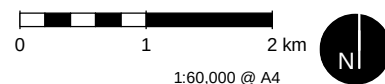


Figure 7.1 | Groundwater assets

Data sources
 DFSI - Spatial Services
 Jacobs 2018

Surface Water

The study area is located within the Shoalhaven Catchment on the south coast of New South Wales. The Shoalhaven Catchment covers an area of approximately 5,640 square kilometres, with the Shoalhaven River running through the centre of catchment (WaterNSW, 2018d). The Shoalhaven River spans from its headwaters near Braidwood in the south-west to Kangaroo Valley in the north-east. The major tributaries of the Shoalhaven River include the Mongarlowe, Corang, Endrick and Kangaroo Rivers (NSW Department of Industry, 2018).

The only large water storage in the Shoalhaven Catchment is Tallowa Dam, with a capacity of 110,200 megalitres. Tallowa Dam is part of the Greater Sydney water supply system, owned and operated by the WaterNSW. It provides water to Shoalhaven Water for local town water supply, forms the lower reservoir of the existing Shoalhaven pumped hydro-electric power scheme and is used to supplement Sydney's water supply in times of drought. The Shoalhaven scheme also includes Fitzroy Falls Dam which serves as the upper reservoir for the existing scheme, and Wingecarribee Reservoir (NSW Department of Industry, 2018).

The closest water sources to the study area include the Fitzroy Falls reservoir (north), Bendeela Pondage and Lake Yarrunga (south), Yarrunga Creek (west) and Miller Creek (east).

Water from the Fitzroy Falls Reservoir and Lake Yarrunga will be used in the operation of the project.

Flooding

The project area is not within land mapped as flood planning area under the Shoalhaven LEP. Maximum flood levels are dictated by the Tallowa Dam spillway level.

7.3.2 Issues for consideration

Ground Water

During construction it is expected that water will seep into the tunnels and caverns and dewatering and management will be required. During operation, small volumes of water is expected to enter the access tunnel and caverns, but not the water tunnels. This has the potential to cause minor draw down of the local water table in the immediate vicinity of the project footprint.

Surface Water and flooding

During construction, impacts to surface water quality may occur during earthworks associated with pipeline construction, access roads, spoil placement development and use of construction compounds. The earthworks required during construction, particularly for the proposed pipeline, has the potential to cause soil erosion and generate downstream sedimentation and water quality impacts if unmanaged.

There is potential for surface water impacts to occur during operation of the project due to increased rate of water transferred between Lake Yarrunga and Fitzroy Falls storages, including increased sedimentation or an increase in turbidity. It is possible that increased flow and turbulence in the vicinity of outlet structures will also increase transport of sediment that may fall out of suspension in the Fitzroy Falls canal or reservoir, or in Lake Yarrunga.

There is potential for construction areas to be impacted during flood events if located within flood prone areas.

7.3.3 Method of assessment

Ground Water

A ground water model will be formulated and used to assess the existing ground water levels within the vicinity of the proposed project footprint. This will then be used to predict the likely impacts to ground water levels during both construction and operation. Given the anticipated low risk nature of the project with respect to groundwater, and lack of relevant borehole data, construction of a detailed numerical groundwater model is not

feasible nor expected to be required. Potential groundwater inflows to the tunnels and caverns will be derived analytically, as will propagation of potential drawdown and depressurisation impacts.

Permanent ground water monitoring wells will be installed in some of the proposed geotechnical investigation boreholes to facilitate a long-term ground water monitoring program to confirm the accuracy of predictions of ground water level changes.

Potential impacts that will be assessed include:

- Construction and operational water level drawdown;
- Predicted dewatering volumes during construction and operation;
- Water quality of dewatering discharge;
- Potential changes to groundwater surface water interaction/baseflow;
- Potential impact to groundwater dependent ecosystems; and
- Impacts to other groundwater users.

Surface Water and Flooding

A surface water impact assessment will consider the existing water quality within the vicinity of Fitzroy Falls Reservoir and Lake Yarrunga and ascertain the likely impacts during both construction and operation. The assessment would include examination of turbidity in both reservoirs as a result of the project.

The assessment is expected to include:

- A review of existing water quality information, and if necessary, a water quality field survey to ascertain water quality conditions in Lake Yarrunga and Fitzroy Falls Reservoir. Water quality data obtained in the survey and existing data will be assessed against the ANZECC/ARMANZ (2000) *Guidelines for Fresh and Marine Water Quality* and NHMRC (2008) *Guidelines for Managing Risk in Recreational Water*;
- Development of a water balance model to provide an assessment of the potential surface runoff and groundwater inflows that will contribute to on-site supply and demand during construction;
- Identification of surface water quality and hydrology impacts associated with the construction and operation of the project; and
- Development of mitigation measures to avoid or minimise these impacts.

Based upon the information obtained from the assessment methodology, a Surface Water Quality and Hydrology Assessment Report will be prepared and included as part of the EIS.

7.4 Bathymetric/ fluvial geomorphology

7.4.1 Existing environment

The elevated waterbody related to the project is the Fitzroy Falls Reservoir, a 5.2 square kilometre man-made lake created and used for the existing scheme. The main embankment of the reservoir is 14 m high and 1,530 m in length (WaterNSW, 2018a). The Fitzroy Falls Reservoir is connected to the surface pipeline by the Fitzroy Falls Canal with the intake structure located at the end of the canal. This is designed as a control structure to regulate flows.

The lower waterbody is Lake Yarrunga, a man-made reservoir created upstream of Tallowa Dam as part of the existing scheme. Lake Yarrunga covers an area of 9.3 square kilometres and is fed by two main rivers, the Shoalhaven River and the Kangaroo River (WaterNSW, 2018b). A number of smaller creeks and streams including Yarrunga Creek and Kings Creek also flow into the lake.

The Fitzroy Falls Reservoir and Lake Yarrunga are currently connected by the existing scheme and no new connection of previously unconnected catchments is proposed.

7.4.2 Issues for consideration

The project will use existing water allocations from within the system, and operate within the same upper and lower bound water levels as the existing scheme. As such no new inundation or reduced water level in either reservoir will result from the project. The rate of water level change in the reservoirs if both the existing scheme and project are operated in the same mode at the same time would almost double. The existing infrastructure was constructed with the scheme expansion in mind and as such the Fitzroy Falls Canal has sufficient capacity to support the increased flow rate.

Increased pumping from and discharge of water to Lake Yarrunga and Fitzroy Falls Reservoir has the potential to impact on turbidity and transport of sediment, which may fall out in suspension. More rapid fluctuations in water levels in Lake Yarrunga and Fitzroy Falls Reservoir could affect bank stability. The design and construction of new infrastructure associated with the project also has the potential to impact on bathymetric and geomorphological conditions in the vicinity of the intake/ outlet structure on Lake Yarrunga.

7.4.3 Method of assessment

A Bathymetric Impact Assessment will be undertaken as part of the EIS and will primarily relate to the assessment of geomorphological conditions and processes within the vicinity of Fitzroy Falls Reservoir and Lake Yarrunga and inlet/ outlet structure to Lake Yarrunga.

7.5 Biodiversity

7.5.1 Existing environment

The majority of the proposed project footprint has been previously disturbed during the construction of existing scheme. However, a review of satellite imagery indicates considerable regeneration and the surrounding locality is known to retain considerable biodiversity values including a number of threatened or endangered species and communities listed under State and Commonwealth legislation.

A background review of available online information was undertaken to identify the existing environment of the proposal within a search area of 10 km. The review focussed on database searches, relevant ecological reports pertaining to the study area, property boundaries, and relevant GIS layers. The review was used to prepare a list of threatened species, populations and communities as well as important habitat for migratory species with a likelihood of occurrence in the study area and locality. The searches were also undertaken to identify if any Areas of Outstanding Biodiversity Value were present.

The following database searches were performed:

- BioNet - the website for the Atlas of NSW Wildlife and OEH Threatened Species Profile Database;
- The federal Department of Environment and Energy Protected Matters Search Tool;
- The Biodiversity Assessment Method (BAM) calculator predicted species function;
- NSW Department of Primary Industries freshwater threatened species distribution maps (DPI, 2016);
- OEH BioNet Vegetation Classification System database;
- The federal Bureau of Meteorology's Atlas of Groundwater Dependent Ecosystems (GDE);
- Department of Environment and Energy directory of important wetlands;
- Atlas of Living Australia;
- Register of Declared areas of Outstanding Biodiversity Value; and
- Key fish habitat maps (DPI 2007).

The search did not reveal any Areas of Outstanding Biodiversity, or Wetlands of National Importance in the study area.

Existing vegetation mapping from the NSW OEH was used as a benchmark to provide information on potential threatened species or communities which may be located in the study area. This also provides approximate expectations for what plant species might be present.

Table 7.2 outlines the PCTs mapped within the study area, with Figure 7.2 illustrating approximate locations of each. Site visits and vegetation surveys would be required to confirm the presence of these Plant Community Types and Endangered Ecological Communities, and to refine the mapping.

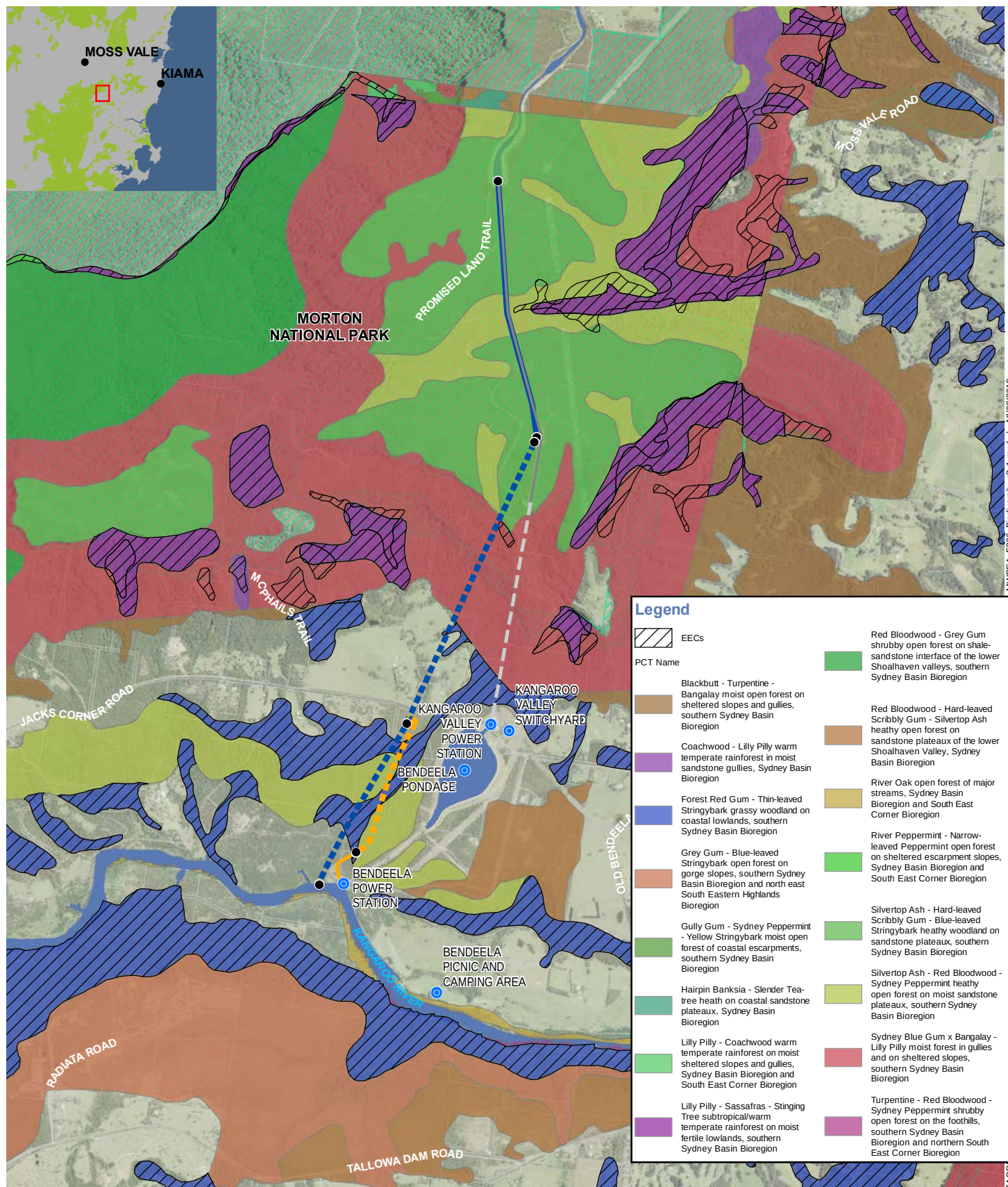
Table 7.2: Plant Community Types mapped as present within the area

PCT#	Community Name
1152	Silvertop Ash - Hard-leaved Scribbly Gum - Blue-leaved Stringybark heathy woodland on sandstone plateaux, southern Sydney Basin
1156	Silvertop Ash - Red Bloodwood - Sydney Peppermint heathy open forest on moist sandstone plateaux, southern Sydney Basin
906	Lilly Pilly - Sassafras - Stinging Tree subtropical/warm temperate rainforest on moist fertile lowlands, southern Sydney Basin
1245	Sydney Blue Gum X Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin
838	Forest Red Gum - Thin-leaved Stringybark grassy woodland on coastal lowlands, southern Sydney Basin
1105	River Oak open forest of major streams, Sydney Basin and South East Corner
1082	Red Bloodwood - Hard-leaved Scribbly Gum - Silvertop Ash heathy open forest on sandstone plateaux of the lower Shoalhaven Valley, Sydney Basin Bioregion

Table 7.3 identifies the two Endangered Ecological Communities (EECs) mapped within the study area, with locations of each illustrated in Figure 7.2.

Table 7.3: Endangered Ecological Communities within the study area

BC Act	EPBC	Community Name
E	CE	Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion
E	-	Illawarra Subtropical Rainforest in the Sydney Basin Bioregion



Legend

- Points of interest
- Indicative above-ground infrastructure
- NPWS Reserve
- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Indicative access road

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Figure 7.2 | PCT and EEC Mapping

Data sources
DFSI - Spatial Services
OEH NSW 2018
Jacobs 2018

Threatened Species which have the potential to occur within the study area were collected from searches across the following databases.

- **NSW OEH Threatened Species Records:** The NSW Office of Environment and Heritage records provides information on species which have been sighted within a 10 km radius of the area. The search returned 28 threatened species records - 23 fauna and five flora.
- **EPBC PMST Potential Threatened Species:** The EPBC Protected Matters Search Tool lists federally listed threatened and endangered species which may occur in the area, or species whose preferred habitat may occur in the area. The search returned 48 potential threatened species, including eight birds, five frogs and reptiles, nine mammals, three fish/crustaceans, and 23 plants; and
- **BAM Calculator Predicted Species:** The Biodiversity Assessment Method (BAM) Calculator is used to predict potentially occurring threatened species based on the mapped PCTs identified above. These can later be used for calculating ecosystem and species credits if the area is being assessed using the BAM. The BAM calculator predicted 38 ecosystem credit species (species which are assumed to be present based on the presence of their habitat), and 48 species credit species (which are species requiring survey).

Once the searches were complete, the compiled list of threatened flora, fauna, and ecological communities was assessed for their likelihood of occurrence (refer to Appendix A).

Likelihood of occurrence for each species identified in the desktop search was assigned based on knowledge of the species' preferred habitats and known distributions, contrasted against the assumed habitat in the study area. Verified sightings of threatened species were also used to determine a species' presence in the area.

The likelihood of Occurrence Table (Appendix A) summarises all potential threatened species which may occur at the site based on the above searches. The table indicates which search the species was listed in, as well as the species known range/habitat, and the deemed likelihood of occurrence at the site.

7.5.2 Issues for consideration

Potential impacts to biodiversity include:

- Vegetation disturbances on the plateau including along sections of the pipeline route, for construction laydown and works areas, at the pipeline anchor location and for the surge tank and vertical shaft;
- Vegetation disturbance in the valley associated with surface works including outlet works, access tunnel portal, network connection infrastructure, spoil disposal, operational compound and construction compounds;
- Noise and light associated with construction may disturb fauna species in the immediate vicinity of works areas;
- Increased vehicle and machinery movements may lead to direct fauna interactions and mortality;
- Erosion and sedimentation could result in adverse downstream impacts within the Morton National Park;
- Changes to hydrogeological and geotechnical conditions may affect groundwater dependent ecosystems; and
- Increased flow-rates within the Fitzroy Falls Canal and vicinity of the outlet on Lake Yarrunga may lead to turbidity and affect aquatic habitat.

7.5.3 Method of assessment

A biodiversity assessment would be undertaken as part of the EIS to assess potential impacts associated with the project. The assessment would focus on potential impacts to listed threatened species and ecological communities and would be undertaken to meet the requirements of the Biodiversity Assessment Method (BAM).

The habitat value of each waterway (i.e. habitat sensitivity and classification of waterways for fish passage) will be characterised in accordance with NSW DPI (Fisheries)' document Policy and Guidelines for Fish Habitat Conservation and Management (2013 update).

To determine the nature and scale of impact, a Biodiversity Development Assessment Report (BDAR) will be prepared as required under the Biodiversity Conservation Act 2016. The BDAR will include the aquatic biodiversity assessment.

7.6 Non-Aboriginal Heritage

7.6.1 Existing environment

Land within the Kangaroo Valley area was first surveyed in 1836 and this resulted in a parcel of 980 acres being offered for sale in early 1837. Since that time, the land has been bought and sold a number of times and primarily utilised for farming practices. In particular, four dairy factories were constructed in Kangaroo Valley between 1888 and 1894, being the Barrengarry Butter Factory, the Kangaroo River Dairy Co, the Upper River Butter Factory and the Kangaroo Dairy Co (Wallis and Greenwell Point Bi-Centennial Sub-Committee 1988).

The following archaeological reports contextualize the broader historical heritage themes of the project area (Table 7.4).

Table 7.4: Previous historical archaeological studies within or surrounding the project area

Author	Summary
Moody <i>et al.</i> (2006)	Early settlement in and around Shoalhaven was focused along the Shoalhaven River. The river facilitated transportation across the landscape and boat access from coastal shipping. European colonisation established a presence of Cedar-getters within the Shoalhaven area to source materials for the timber industry. Early agricultural pursuits of Shoalhaven included wheat cropping, cattle grazing and hog farming. Regular flooding of the Shoalhaven areas is also reported. Historic sites of Shoalhaven include early houses, wharves, ferries, boatyards and agricultural outbuildings.
Shoalhaven City Council (2003)	Freeman Collett and Partners, Conservation Architect and Planners were awarded a heritage study for the City of Shoalhaven area. Many of the historic heritage items identified in this assessment are not relevant to the project. The relevant areas include Kangaroo Valley (Zone 1 within the City's assessment). Twenty-nine historic heritage items have been identified near the Project area (mainly to the south east). The majority of these include cottages and residences with some inclusions of Schools, Post Offices, Bakeries, Memorials and a bridge. The twenty-nine historic heritage items include: · Kangaroo Valley Town Centre (KV001, Kangaroo Valley) · Anglican Church Good Shepherd and Graveyard (KV001.01, 143 Moss Vale Road) · Kangaroo Valley Courthouse and Police Station (KV001.02, 175 Moss Vale Road) · Kangaroo Valley Hall (KV001.03, 177 Moss Vale Road) · Osbourne Park (Kangaroo Valley Showground) (KV001.04, 177 Moss Vale Road) · Kangaroo Valley House (formerly Jarman's cottage) (KV001.05, 170 Moss Vale Road) · Weatherboard Cottage (KV001.06, 172 Moss Vale Road) · Old Bakery (KV001.07, 174 Moss Vale Road) · Federation Cottage (former Baker's residence) (KV001.08, 178 Moss Vale Road) · Orkney Post War Weatherboard Cottage (KV001.09, 126 Moss Vale Road) · Federation Weatherboard Cottage (KV001.10, 124 Moss Vale Road) · Federation Weatherboard Cottage (KV001.11, 120 Moss Vale Road) · Federation Weatherboard Cottage (KV001.12, 118 Moss Vale Road) · Federation Weatherboard Cottage and shop (KV001.13, 116 Moss Vale Road) · Kangaroo Valley pre School (former Old Beaumont School) (KV001.14, 140 Moss Vale Road) · Hilltop Federation Residence (KV001.15, 20 Quirk Street) · St Joseph's Catholic Church and Franciscan Hermitage (KV001.16, 130 Moss Vale Road) · Kangaroo Valley Soldiers Memorial (KV001.17, Moss Vale Road) · Kangaroo Valley Post Office (KV001.18, 148 Moss Vale Road) · Late Victorian Weatherboard Residence (KV001.19, Quirk Street) · Fudge House (former ANZ bank) (KV001.20, 158 Moss Vale Road)

Author	Summary
	· Kangaroo Valley School and (former) residence (KV001.21, 140 Moss Vale Road) · Talangi Federation Weatherboard House (KV001.22, 141 Moss Vale Road) · Friendly Inn (former Commercial Hotel) (KV001.23, 159 Moss Vale Road) · Barrengarry House Victorian Residence (KV002, 171 Upper Kangaroo River Road) · Residence (former Anglican Church Good Shepherd Rectory) (KV003, Rectory Park Way) · Residence (former Barrengarry School and Residence) (KV004, Bunker Hill Road) · Hampden Bridge (KV005, Moss Vale Road) · Pioneer Farm and Historic Village (former Rendall House) (KV006, Moss Vale Road)

Heritage Register Searches

A search of the following heritage registers was undertaken on 19 September 2018:

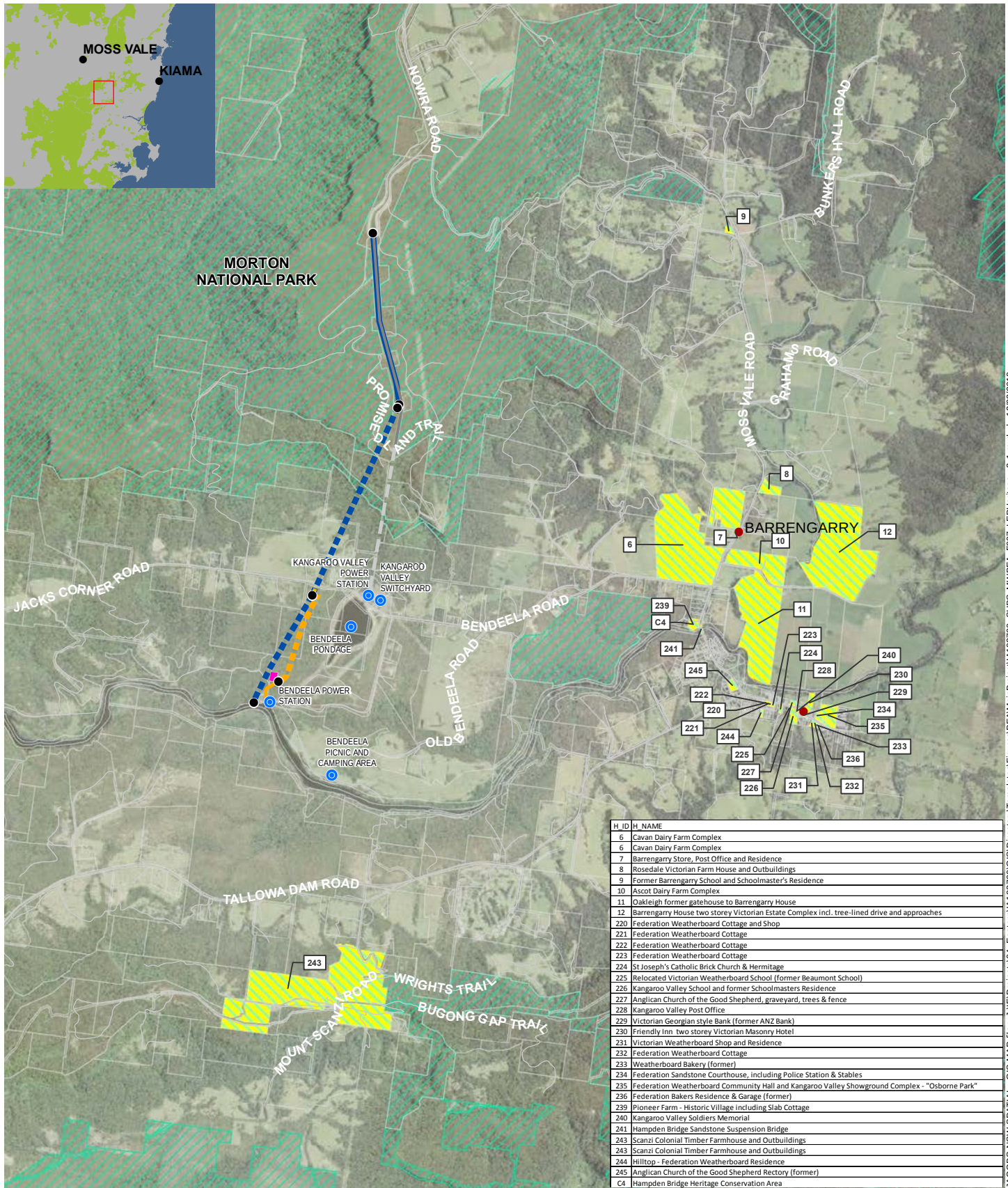
- NSW State Heritage Register (SHR);
- NSW State Heritage Inventory;
- Section 170 Registers;
- World Heritage List (WHL);
- National Heritage List (NHL);
- Commonwealth Heritage List (CHL);
- Register of National Estate (RNE);
- Shoalhaven LEP 2014;
- Wingecarribee LEP 2010; and
- Regional Environmental Plan (REP).

Searches of the historical databases identified 26 heritage items within the locality (see Table 7.5). The location of these items is illustrated in Figure 7.3.

Table 7.5 : Results of heritage database searches

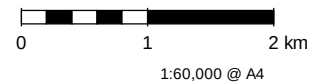
Item name	Address	Property description	Significance	Item number	Register
"Cavan" - dairy farm complex	30 Cavan Road	Lot 7, DP 869740	Local	6	Shoalhaven LEP
"Hilltop" - Federation Weatherboard Residence	20 Quirk Street	Lots 20 and 21, DP 2159	Local	244	Shoalhaven LEP
Federation Weatherboard Cottage and Shop	116 Moss Vale Road	Lot 1, DP 828529	Local	220	Shoalhaven LEP
Federation Weatherboard Cottage	120 Moss Vale Road	Lot 1, DP 883219	Local	222	Shoalhaven LEP
Federation Weatherboard Cottage	124 Moss Vale Road	Lot 101, DP 840159	Local	223	Shoalhaven LEP
"St Joseph's" Catholic Brick Church & Hermitage	130 Moss Vale Road	Lot 1, DP 724070	Local	224	Shoalhaven LEP
Anglican Church of the Good Shepherd, graveyard, trees & fence	143 Moss Vale Road	Lot 1, DP 724064	Local	227	Shoalhaven LEP

Item name	Address	Property description	Significance	Item number	Register
"Pioneer Farm" - Historic Village including Slab Cottage	2029 Moss Vale Road	Lot 7007, DP 1075462	Local	239	Shoalhaven LEP
Relocated Victorian Weatherboard School (former Beaumont School)	138 Moss Vale Road	Lot A, DP 409799	Local	225	Shoalhaven LEP
Kangaroo Valley School and former Schoolmasters Residence	140 Moss Vale Road	Lot 1, DP 122562; Lot 1, DP 913316	Local	226	Shoalhaven LEP
Kangaroo Valley Post Office	148 Moss Vale Road	Lot 2, DP 926830	Local	228	Shoalhaven LEP
Victorian Georgian style Bank (former ANZ Bank)	158 Moss Vale Road	Lot 2, DP 559041	Local	229	Shoalhaven LEP
"Friendly Inn" two storey Victorian Masonry Hotel	159 Moss Vale Road	Lot 4, DP 11616	Local	230	Shoalhaven LEP
Victorian Weatherboard Shop and Residence	170 Moss Vale Road	Lot 1, DP 1182201	Local	231	Shoalhaven LEP
Federation Weatherboard Cottage	172 Moss Vale Road	Lot 9, DP 1940	Local	232	Shoalhaven LEP
Weatherboard Bakery (former)	174–176 Moss Vale Road	Lots 10 and 11, DP 1940	Local	233	Shoalhaven LEP
Federation Bakers Residence & Garage (former)	178 Moss Vale Road	Lot 1, DP 576156	Local	236	Shoalhaven LEP
Federation Weatherboard Community Hall and Kangaroo Valley Showground Complex - "Osborne Park"	177–181 Moss Vale Road	Lot 1, DP 1003243; Lots 1 and 2, DP 210368; Lots A and B, DP 376259; Lot D, DP 409219; Part Lot 1, DP 909749	Local	235	Shoalhaven LEP
Federation Sandstone Courthouse, including Police Station & Stables	175 Moss Vale Road	Lot 4, DP 589396	Local	234	Shoalhaven LEP
"Ascot" - dairy farm complex	49 Upper Kangaroo River Road	Lot 18, DP 773481	Local	10	Shoalhaven LEP
"Oakleigh" - (former gatehouse to Barrengarry House)	89 Upper Kangaroo River Road	Lot 1, DP 746459	Local	11	Shoalhaven LEP
Kangaroo Valley	Kangaroo Valley Road	N/A	N/A	1589	RNE
Former Barrengarry School and schoolmaster's residence	2565 Moss Vale Road	Lot 2565, DP 1118533	Local	9	Shoalhaven LEP
"Rosedale" - Victorian farmhouse and outbuildings	2240 Moss Vale Road	Lot 101, DP 623325	Local	8	Shoalhaven LEP
Anglican Church of the Good Shepherd rectory (former)	Rectory Park Way	Lot 9, DP 285133	Local	245	Shoalhaven LEP
"Barrengarry House" - two storey Victorian estate complex including tree-lined drive and approaches	171 Upper Kangaroo River Road	Lot 1 DP 259769; Part Lot 1, DP 195569	Local	12	Shoalhaven LEP



Legend

- Points of interest
 - Indicative above-ground infrastructure
 - NPWS Reserve
 - LEP Heritage
 - Former Benedeela Public School
 - Existing KV tunnel alignment
 - Existing scheme pipeline
 - Indicative above ground pipeline
 - Indicative tunnel alignment
 - Indicative access tunnel
 - Indicative access road
- Figure 7.3** | LEP heritage



Data sources
 DFSI - Spatial Services
 Jacobs 2018

As can be seen from Table 7.5, all but one of the heritage items listed in the Shoalhaven LEP are of local heritage significance. One item, however, was listed on the Register of National Estate, (RNE), which no longer holds any statutory power, being the “Kangaroo Valley”.

In addition to the items listed above, several other potential items have been identified through historical research (Table 7.6).

Table 7.6 : Additional historical items

Item name	Description
Former Barrengarry Cemetery	The former Barrengarry cemetery is located to the east of the Bendeela pondage associated with the Kangaroo Valley Power Station, on the northern side of Bendeela Road. A Church of England church and parsonage was also planned for that parcel of land. The cemetery was dedicated on 4 February 1876 and acquired by the Metropolitan Water Sewerage & Drainage Board in 1971 (Gazette No. 52, 14 May 1971, pp 1549-1550). It is not clear, however, whether the church, parsonage and/or cemetery were ever built or used. A high tension transmission tower currently occupies the north western corner of the parsonage site as part of the Dapto-Canberra 330kV transmission line. Additional research would be required to ascertain whether this cemetery was every used, and whether the church and/or parsonage was ever built.
Former Bendeela Public School	The former Bendeela public school site lies to the south west of the Bendeela pondage in bushland, currently described as lot 216 in Deposited Plan 751262. The Bendeela Public School was constructed in 1880 with additional buildings constructed in 1899.

7.6.2 Issues for consideration

Construction of the project has the potential to impact unidentified historical heritage items through clearance of vegetation, construction of infrastructure and any earthworks.

During operation, the project has limited potential to impact historical heritage, however, inadvertent impact may occur as a result of increased visitation to the area.

7.6.3 Method of assessment

A non-Aboriginal heritage impact assessment will be undertaken in accordance with the Burra Charter published by ICOMOS Australia and will include the following tasks:

- A review of Commonwealth, National, State and local heritage databases for items already recorded within the vicinity of the study area, and preparation of historical context, including review of previous heritage reports;
- Significance assessment of heritage items that could potentially be impacted; and
- An archaeological survey to inspect heritage values identified in the desktop assessment and those areas where ground disturbance works are proposed. In addition, the survey will identify areas of potential historical archaeology not previously known or recorded and will identify areas of potential archaeological sensitivity.

The assessment will inform a *Statement of Heritage Impact* which fulfils guidelines detailed in *Statement of Heritage Impact* (HO/DOUAP 2002). The report will identify potential impacts on any heritage values of the areas of proposed works and provide recommendations for the mitigation of any impacts.

7.7 Aboriginal Cultural Heritage

7.7.1 Existing environment

The majority of the proposed development footprint has been previously disturbed during the construction of existing scheme. Aerial imagery indicates the project is surrounded by National Park land on the plateau with rural residential and agricultural properties within Kangaroo Valley. The closest water sources include Fitzroy Falls reservoir (north), Bendeela Pondage and Lake Yarrunga (south), Yarrunga Creek (west) and Miller Creek (east).

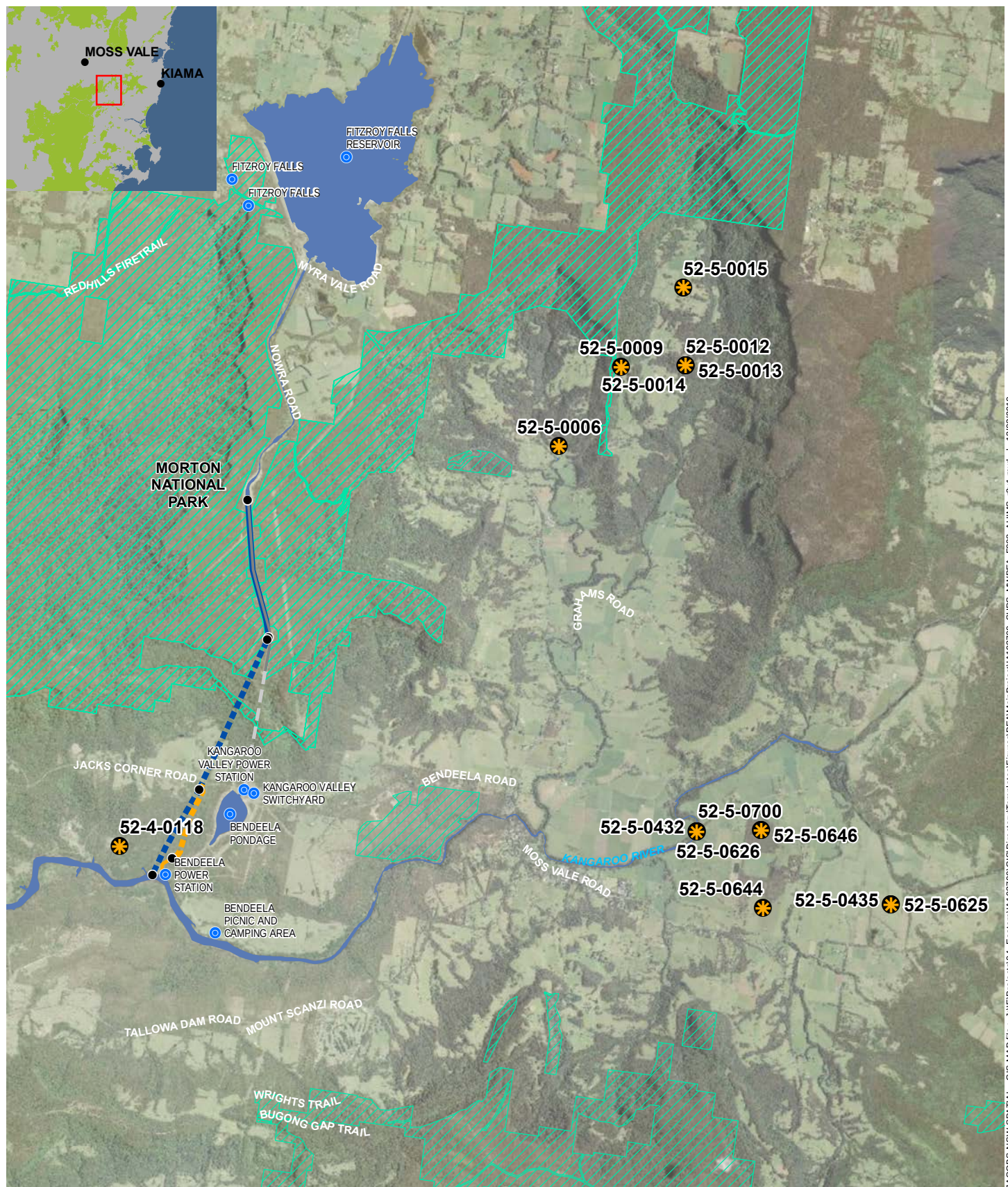
A search of the Aboriginal Heritage Management System (AHIMS) was undertaken as part of the initial assessment for the Aboriginal heritage component of the project study area. These findings were further contextualized through a review of historical, archaeological and heritage reports pertaining to the project study area. Based on these assessments a predictive model of potential site types and their associated characteristics was formulated. A search of the Australian Heritage Database and NSW heritage database was also undertaken and no Aboriginal sites within these databases were identified. It is recognised that the AHIMS database identifies only officially recorded Aboriginal sites and therefore does not necessarily represent a complete recording of Aboriginal sites within the area.

An extensive AHIMS search was undertaken on 13 September 2018 using a 'shapefile' search of the Project area. No registered Aboriginal heritage sites were identified within the project study area.

To contextualise the broader archaeological character of the area another search was undertaken on 17 September 2018 using the 'map feature' with a search buffer of 200 m. The AHIMS search identified no Aboriginal sites within the project area and 15 surrounding the project study area (Table 7.7, Figure 7.4).

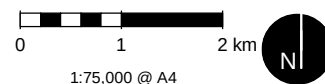
Table 7.7 : AHIMS sites within 200 m of the Project Study Area

AHIMS ID	Site name	Easting	Northing	Site features	Site type
52-5-0006	Barrengarry	273259	6159554	Grinding Groove :	Axe Grinding Groove
52-5-0009	Bunkers Hill	274786	6160957	Grinding Groove :	Axe Grinding Groove
52-5-0013	Bunkers Hill	275057	6161145	Grinding Groove :	Axe Grinding Groove
52-5-0014	Bunkers Hill	275057	6161145	Grinding Groove :	Axe Grinding Groove
52-5-0015	Bunkers Hill	275136	6161787	Grinding Groove :	Axe Grinding Groove
52-4-0118	Lake Yarrunga 4	266927	6153640	Artefact : 1	N/A
52-5-0435	KVAS 1	277897	6153130	Artefact : 11	N/A
52-5-0432	Kangaroo Valley 1	275966	6154118	Artefact : 2, Potential Archaeological Deposit (PAD) : 1	N/A
52-5-0012	Barrengarry	275057	6161145	Grinding Groove	Axe Grinding Groove
52-5-0625	Kangaroo Valley Artefact Scatter Duplicate copy of 52-5-0435	277897	6153130	Artefact : 11	N/A
52-5-0626	Kangaroo Valley Isolated Find 1 (Duplicate copy of 52-5-0432)	275964	6153930	Artefact : 1	N/A
52-5-0644	Kangaroo Valley PAD 1	276350	6153400	Artefact : 12, Potential Archaeological Deposit (PAD) : 1	N/A
52-5-0645	Kangaroo Valley 2	276119	6153913	Artefact : 14, Potential Archaeological Deposit (PAD) : 1	N/A
52-5-0646	Kangaroo Valley 3	276309	6153716	Artefact : 1, Potential Archaeological Deposit (PAD) : 1	N/A
52-5-0700	KVSS Artefact Repatriation	276275	6154244	Artefact : 41	N/A



Legend

- Points of interest
- Indicative above-ground infrastructure
- ★ AHIMS sites
- NPWS Reserve
- Existing KV tunnel alignment
- Existing scheme pipeline
- Indicative above ground pipeline
- Indicative tunnel alignment
- Indicative access tunnel
- Indicative access road



Data sources

DFSI - Spatial Services
AHIMS OEH NSW 2018
Jacobs 2018

Figure 7.4 | Registered Aboriginal sites (AHIMS) within 200m the project area

Table 7.8 provides summaries of archaeological reports that contextualize the broader Aboriginal heritage themes of the project locality.

Table 7.8 : Previous Aboriginal archaeological studies surrounding the project area

Author	Summary
Artefact Heritage (2018)	Artefact Heritage undertook an Aboriginal Cultural Assessment Report as part of the proposal to construct a new bridge on the A1 Princes Highway over the Shoalhaven River at Nowra (some 20 km south of the project area) in accordance with Roads and Maritime Stage 3 Procedure for Aboriginal Cultural Heritage Consultation and Investigation. The survey identified five Aboriginal sites and five areas of Potential Aboriginal Deposits. These included artefact scatters, scarred trees, sub-surface deposit and grinding grooves. Artefact scatters were generally associated with alluvial floodplains and included hammerstones and microliths made from a variety of different raw materials including glass.
Kuskie (2008)	Manildra Group engaged South East Archaeology to undertake an Aboriginal Heritage Impact Assessment of the proposed ethanol plant upgrade at Shoalhaven Starches (located some 22 km south of the project area). The survey undertaken a part of this assessment included an area of 4160m ² of the Shoalhaven River levee on the western side of the factory and 2240m ² on the levee on the eastern side of the factory. Posited to be related to the extent of recent land use impacts no Aboriginal heritage evidence was identified. Those artefacts previously identified within the area were deemed to be unlikely to reflect archaeological potential because of the disturbance already related to the study area.
Clarke and Kuskie (2006)	This report composed the fourth stage of the Lower Shoalhaven River Valley Aboriginal Heritage and Cultural Mapping Project for DECC. The spatial model, developed by Clarke and Kuskie (2006) was used to predict Aboriginal site occurrence using key environmental variables. Extrapolated from the research of Boot (2002), Clark and Kuskie's model identified two main resource zones within the Shoalhaven region; primary resource zones and secondary resource zones. Primary zones were defined as areas close to major rivers (e.g. Shoalhaven and Crookhaven) and predicted to have higher probability of archaeological evidence of continued occupation related to gathering, camping and congregational use of these areas. Secondary resource zones were defined as land close to higher order creeks and associated flats, terraces and slopes and evidence of sporadic occupation for nuclear family camps and hunting parties. Their predictions based on this model suggested: - artefact scatters were the most likely site type within the Project area. - grinding grooves and rock shelters may also occur. Rock shelters are likely to occur in steep drainage depressions or spur crest units or sloping terrain. Grinding grooves are likely to occur on homogenous stone outcrops such as sandstone close to water sources.

Predictive modelling

Based on the search of the AHIMS and Australian Heritage database and review of previous archaeological reports pertaining to the broader project locality, the following site types, characteristics and potential location of Aboriginal places within the project area are identified:

- Artefact scatters, grinding grooves, PADS, scarred trees and rock shelters are likely to be associated with primary resources zones along major rivers and also evident along higher order creek flats, slopes and terraces;
- Grinding grooves and rock shelters are a likely site type. Rock shelters are likely to occur in steep drainage depressions or spur crest units or sloping terrain. Grinding grooves are likely to occur on homogenous stone outcrops such as sandstone close to water sources;
- Artefact scatters and isolated artefacts are a likely site type. These are likely to be located along alluvial floodplains and are likely to include surface and subsurface deposits;
- PADs are a likely site type. Surface scatters may indicate potential for sub-surface deposit; and
- Scarred trees are a less likely site type. These are less abundant and are likely to occur in mature vegetation and in the vicinity of or in association with other cultural and archaeological material.

Preliminary Site Inspection – 3rd and 4th December 2018

A preliminary site inspection has been undertaken as part of the Aboriginal cultural heritage impact assessment. The purpose of the preliminary site inspection was to visit all areas where surface impacts associated with the project are proposed in order to identify whether or not Aboriginal objects are, or are likely to be, present, and whether or not the proposal is likely to harm Aboriginal objects.

The preliminary site inspection had the following objectives:

- Inspect areas of higher visibility and soil exposures;
- Inspect elevated areas near waterways, water bodies and creek lines;
- Inspect all rock shelters within the Project area; and
- Inspect all mature trees in the Project area for cultural modification or scarring.

The preliminary site inspection was undertaken in accordance with the due diligence code of practice from 3 - 4 December 2018. Andrew Costello (Senior Archaeologist, Jacobs) undertook the inspection with Thomas Muddle, Jorja Vernon, Mike Luger and Ajay Arcot (Environmental Services, Jacobs), and Tony Schinkel (Origin). Details of conditions were recorded using a field notebook and differential GPS. Photos were taken with a digital camera. Information recorded during the inspection included:

- Landforms;
- Observable disturbance;
- Ground surface visibility (GSV);
- Areas of exposure; and
- Areas of potential archaeological sensitivity.

The project area is characterised by steep hills, valleys, ridgelines and flat alluvial terraces. Some areas of alluvial deposits are found adjacent to waterways, particularly near Tallowa Dam (Lake Yarrunga). The vegetation comprises fairly dense stands of native trees. Much of the Project area has been heavily disturbed. As expected in such conditions, there are unlikely to be many visible Aboriginal objects, and what traces of past Aboriginal behaviour remain are largely obscured by the heavy vegetation and resultant low GSV. In forested areas, visibility was low and the terrain included some ephemeral and highly eroded drainage lines.

The preliminary site inspection confirmed that most of the project would occur within significantly disturbed landforms, with extensive ground disturbance from the original pipeline and project construction. There were no Aboriginal objects or sites identified during the inspection. One area of moderate archaeological sensitivity was recorded near the intake site adjacent near Lake Yarrunga.

7.7.2 Issues for consideration

Although no registered AHIMS sites were identified within the project area, the continuous flooding and largely undeveloped landscape does indicate potential for previously unidentified archaeological remains. Moreover, the cultural heritage values of the Shoalhaven River and its immediate environment encompass a cultural significant landscape underpinned by sporadic tangible remains and intangible social and cultural associations to the landscape (Moody *et al.* 2006).

Fifteen Aboriginal heritage sites were identified within 200 m of the project area. None of the registered Aboriginal sites intersect with the project area. However, the alluvial context of the area through flooding does indicate potential for Aboriginal heritage artefacts to be identified within the area.

Aboriginal objects are often associated with particular landscape features. As per the Due Diligence Code of Practice, consideration of likelihood of Aboriginal objects with regards to association of landscape features “if your proposed activity is within 200 m of waters and is not on disturbed land and disturbance cannot be avoided, you must undertake a desktop assessment and visual inspection”. As mentioned in Section 7.7.1, a number of watercourses are directly adjacent to, or directly intersect with, the project area. Consultation with

local Aboriginal community groups identified Shoalhaven River as a 'defining element of country'. The river is described to demonstrate social, linguistic, place stories, daily practices and belief affiliations. The river was also a primary subsistence source to Aboriginal people of the area (Moody et al. 2006).

While the majority of the project area has been previously disturbed by vegetation clearance and earthworks, there is potential for the works to disturb unidentified Aboriginal sites.

7.7.3 Method of assessment

An Aboriginal Heritage Impact Assessment is likely to be required in areas of limited to previous disturbance. The initial assessment will entail a detailed walkover of such areas by an archaeologist and representatives of the local Aboriginal community. If any Aboriginal sites are identified and need to be disturbed, further detailed investigations and consultation with the local Aboriginal community will be required.

An Aboriginal Archaeological Survey Report will be prepared which fulfils the requirements of the Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales (DECCW, 2010). The report will identify potential impacts on Aboriginal cultural heritage values and provide recommendations for mitigation of any impacts in consultation with the Registered Aboriginal Parties.

7.8 Noise and vibration

7.8.1 Existing environment

The study area is located near several communities and townships including Barrengarry and Kangaroo Valley in the vicinity of the lower portion of the project; and Fitzroy Falls, Wildes Meadow, Avoca and Burrawang near the existing Fitzroy Falls Reservoir. The ambient noise environment in the majority of the study area is defined by natural elements and limited human activity, therefore the surrounding area has the potential to be exposed to noise and vibration associated with construction of the project.

The existing Shoalhaven scheme pipeline, tunnel, pondage and the associated Kangaroo and Bendeela Power Stations are in proximity to the project footprint. Tunnelling would also proceed under the escarpment/footslopes at depths in excess of 100 m.

7.8.2 Issues for consideration

In addition to general construction noise, the following activities have the potential to generate noise and vibration impacts:

- Excavation of the powerhouse and transformer caverns, which may involve techniques including blasting and heavy machinery use, could generate adverse noise and vibration conditions with potential for noise impact on nearby residences and vibration impact on surrounding infrastructure;
- Rock excavation has the potential to cause noise impact on surrounding residents, while vibration could impact on nearby residents and infrastructure; and
- Truck movements required for the importation of construction material and equipment, as well as possibly for spoil could lead to traffic noise impacts to residents along the transport routes.

The major operational components of the project would be housed underground and as such there is limited potential for operational noise impacts. The design of the cavern ventilation system would need to consider and avoid the potential for noise impacts.

7.8.3 Method of assessment

A Noise and Vibration Impact Assessment will be carried out to assess the level of noise and vibration anticipated from the project and would include:

- Establishment of construction and operational noise criteria;

- Assessment of construction and operational noise and vibration impacts; and
- Development of reasonable and feasible mitigation measures.

Attended and unattended noise monitoring would be undertaken to confirm acoustically-significant site features, including potentially noise affected sensitive receivers and vibration-sensitive structures. Background noise monitoring would be undertaken in accordance with the methodology outlined in the NSW Noise Policy for Industry (NPI) (EPA, 2017) and *AS1055 Acoustics: Description and measurement of environmental noise*. The operational noise criteria for assessing the project will be established in accordance with the NPI. Construction noise criteria will be established in accordance with the *NSW Interim Construction Noise Guideline* (ICNG) (DECC, 2009). Ground vibration criteria will be considered in accordance with *Assessing Vibration: A technical guideline* (DEC, 2006).

A site-specific 3D (SoundPLAN) noise model would be established which considers local topography, screening from existing structures and buildings and the effect on noise from local meteorological conditions.

Potential noise impacts during construction will be assessed in accordance with the ICNG. The potential for noise impacts from the proposed construction activities would be modelled using the 3D noise model. Where night time construction is required, predicted peak noise impacts shall also be assessed to consider sleep disturbance potential at nearest receivers. The construction noise assessment will also consider the noise impact from the additional traffic generated on public roads by the project. These impacts will be considered in accordance with the NSW Road Noise Policy (RNP).

The majority of operational noise generating equipment will be located underground and as such, operational noise impacts are likely to be relatively minor. An assessment of potential operational noise impacts would be carried out through predictive noise modelling. Noise levels during typical, favourable and adverse meteorological conditions would be assessed in accordance with the NSW NPI.

Potential vibration impacts will be considered in terms of human comfort and potential building damage criteria in accordance with *Assessing Vibration: A technical guideline* (DEC, 2006) and *DIN 4150-3 Structural vibration – Effects of vibration on structures*.

Based on the findings of the noise assessment, mitigation measures and/or abatement management principles would be recommended and outlined in a Noise and Vibration Impact Assessment Report to be include as part of the EIS.

7.9 Traffic and transport

7.9.1 Existing environment

Moss Vale Road is the main road that will be used to access both the upper and lower portions of the study area during construction and operation. Moss Vale Road links Nowra to the Southern Highlands via Kangaroo Valley. The road features narrow and steep mountain passes through Barrengarry and Cambewarra and is an important route within the southern region, providing access for freight, tourism and local traffic (RMS, 2018). The most recent traffic survey for Moss Vale Road was in 2007 by Roads & Maritime Services (RMS, 2007). Traffic counts for Moss Vale Road near Kangaroo Valley (150 m north of Jenanter Drive) recorded an average daily traffic count of 1,552 for north-bound traffic and 1,591 for south-bound traffic. Of these, 94 per cent were light vehicles and six per cent were heavy vehicles.

Access arrangements will differ for the construction sites proposed in the lower and upper portions of the study area. On top of the plateau, the terrain is steep and forested and will require access via the Morton National Park access tracks from Moss Vale Road. Access to the outlet works situated at Lake Yarrunga will be via Lower Bendeela Road from Bendeela Road and Moss Vale Road.

7.9.2 Issues for consideration

Traffic generated during construction works could have impacts on local traffic and the local road network. Traffic generation would include small vehicles driven by construction workers and the delivery of construction equipment and materials. Most deliveries will be associated with concrete and steel pipes for the works on the plateau, and delivery of concrete, steel pipes and equipment within the valley.

No ongoing change in traffic during operation of the project is anticipated.

7.9.3 Method of assessment

A traffic impact assessment will be conducted to assess the impact of the proposed works on traffic, in accordance with RTA Guide to Traffic Generating Developments, Austroad Guide to Traffic Management Part 3, Traffic Studies and Analysis and AS2890.1 and AS2890.2 Australian Standards for off street parking. This will include:

- Assessment of existing conditions including access arrangements, traffic volumes, intersection configuration and existing levels of service;
- Estimate of traffic generated by construction;
- Estimate of likely traffic assignment including haulage routes;
- Assessment of the road network to determine impacts on road network performance;
- Road Safety Assessment; and
- Identification of measures to mitigate the impacts of the proposed construction stages.

A Traffic Impact Assessment report will be included as part of the EIS.

7.10 Air Quality

7.10.1 Existing environment

Existing sources of air pollution within the local setting are limited, consisting primarily of dust and vehicle/machinery exhaust emissions associated with transport along Moss Vale Road. The region surrounding the site is sparsely populated, with most of the land comprised of rural residential properties, agricultural land and the Morton National Park. The South Coast Concrete Crushing and Recycling works (SCCCR) is the closest non-project related activity that is likely to produce air quality impacts to the region. The SCCCR works are located approximately 25 km away from the project.

7.10.2 Issues for consideration

Construction has the potential to generate air quality impacts on sensitive receivers due to the following:

- Use of diesel generators and equipment during construction;
- Excavation and material removal works generating dust;
- Transport of spoil on trucks or conveyors could generate dust;
- Spoil stockpiling and emplacement;
- Vehicle movements over unsealed roads could generate dust; and
- Operation of backup generator during operation.

Due to the nature of the soil and rock in the study area (refer to Section 7.2), and the standard mitigation measures that will be employed to minimise dust, air quality impacts to the surrounding region are expected to be negligible.

As discussed in Section 3, the project will include a ventilation shaft from the powerhouse / transformer caverns. Accordingly, heat emission is expected. A back-up generator may also be required. These will be considered and addressed in the EIS.

7.10.3 Method of assessment

The air quality assessment will identify key risks associated with the project for example construction dust impacts on sensitive receivers. Spoil management will be a key factor in the assessment to ensure spoil has effective controls for air quality management.

The air quality assessment will focus on construction dust emissions and will be based around the quantitative prediction of air quality impacts, in accordance with the assessment guidelines from the EPA, namely, the "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (EPA, 2016).

Specific tasks will include:

- Developing an air emission inventory for earthworks and spoil management activities; and
- Preparing and running air quality models for a worst-case scenario and comparing results with EPA criteria.

Results will inform key areas of dust impact expected and appropriate mitigation measures to be employed and where they should be implemented. An Air Quality Impact Assessment Report would be included in the EIS.

7.11 Climate Change and Greenhouse Gas Emissions

7.11.1 Existing environment

Climate in the region is dictated by a number of complex interactions between larger scale climate patterns, in particular the El Nino Southern Oscillation, and more localised influences including orographic uplift due to the Illawarra Escarpment and the proximity to the coast (OEH, 2014). Rainfall varies considerably in the region, with inland areas typically receiving less precipitation than coastal areas each year. Kangaroo Valley (Main Road) weather station records a mean annual rainfall of 1,288 ml per year (BOM, 2018a). Rainfall is relatively uniform throughout the year but is usually higher in autumn and summer. On the escarpment and close to the Southern Highlands, average temperatures during summer range between 18 – 20 °C and 4 – 6 °C during winter (OEH, 2014).

OEH (2018) identified key climate change projections for the region by 2070 as follows:

- Mean temperatures are projected to rise by 1.9 °C by 2070. The increases are occurring across the region with the greatest increase during summer. Larger increases are also being seen in the west of the region during summer and spring;
- Rainfall will continue to be variable across the Illawarra. The greatest increases are predicted along the coastline and in the south during autumn and summer. The greatest decreases are in the south-west during winter and spring;
- Severe fire weather is projected to increase across the region. These increases are being seen during the peak prescribed burning season (spring) and peak fire risk season (summer); and
- Hot days are projected to increase across the region by an average of 5 days per year. The greatest increases are seen west of Nowra which is projecting an increase of 5 to 10 additional hot days per year.

7.11.2 Issues for consideration

Climate Change

The following climate change risks are identified for the project:

- Severe weather events, such as increased frequency and severity of drought, extreme rainfall events and/or flooding events;
- An increase in the incidence of bushfires in the areas of vegetation surrounding the surface area of the project; and
- Changes in the seasonality of the region and the amount of annual precipitation and runoff which can be captured in the existing scheme storages.

Greenhouse Gas Emissions

The operation of the project facilitates the decarbonisation of the NEM through providing energy storage and dispatchable energy and as such ultimately should be viewed as having a positive greenhouse gas outcome through allowing displacement of more carbon intensive dispatchable energy.

The potential for direct greenhouse gas (GHG) emissions from the project are primarily limited to construction with the following impacts anticipated:

- Use of construction machinery; and
- Consumption of materials, particularly large quantities of concrete and steel.

The project would operate as a net consumer of energy, whereby energy from the electricity grid is used to pump water from Lake Yarrunga to the Fitzroy Falls Reservoir during periods of low demand; and when demand for energy increases, energy is then generated through the return of water to Lake Yarrunga. The project would indirectly contribute to the emission of greenhouse gases because of the percentage makeup of the NEM that are fossil-fuel consumers, however the scheme itself would not produce GHG emissions during operation. Because of energy loss due to the inefficiency of the pumping and generating cycle, the greenhouse gas intensity of the scheme would be slightly higher than that of the NEM.

Some minor GHG emissions expected from operation of the project include:

- Use of diesel-fuelled back-up generators which are likely to be tested monthly and utilised approximately once a year; and
- Use of vehicles associated with inspection and maintenance activities.

7.11.3 Method of assessment

Climate Change

A Climate Change Risk Assessment will be undertaken as part of the EIS and will influence design considerations. This will identify aspects of the project which have potential to be at risk from climate change, provide analysis and evaluation of the risks and propose mitigation (adaptation) measures to be implemented. The report will be prepared in accordance with relevant standards and guidelines.

The construction and operation of the project is a response to the transition to renewable energy generation and is not considered to have an adverse impact on the rate or magnitude of climate change.

Greenhouse Gas Emissions

An Energy and Greenhouse Gas Assessment will be undertaken to identify and quantify key emission sources associated with the construction and operation of the project. A report will be prepared in accordance with *ISO AS14064-2:2006 – Greenhouse Gases*.

Specific, the greenhouse gas assessment would include:

- Develop a greenhouse gas inventory for construction;
- Assess qualitatively operational energy and GHG emissions; and
- Providing high level recommendations for reducing GHG emissions.

7.12 Visual

7.12.1 Existing environment

The surrounding area includes locations that are considered to have high scenic value, particularly within the Morton National Park and Kangaroo River Nature Reserve.

7.12.2 Issues for consideration

Clearing of vegetation and ground disturbance during construction along the existing pipeline would result in long-term localised visual impacts and minor increase in industrialisation in Kangaroo Valley and adjacent to Morton National Park. In addition, access tracks, excavation, tunnelling and the presence of plant and vehicles during construction may result in short-term temporary visual impacts for road users and Morton National Park visitors.

The scale of the project would be visible to a limited number of near-field receptors only and is expected to be largely unnoticeable from sensitive viewpoints.

The majority of the works would be in areas that are not visible from areas outside the Morton National Park (the pipeline) or are below ground. However, two elements of the works have the potential to create visual impacts being:

- Additional infrastructure in Kangaroo Valley associated with the outlet works and the above ground infrastructure associated with access and ventilation of the caverns; and
- A second surge tank, adjacent to the existing surge tank on the plateau, noting that views of the existing surge tank are limited.

7.12.3 Method of assessment

The EIS would include an assessment of visual impacts during construction and operation, including a description of existing landscape character and potential visual receivers, and identification of measures to be used to minimise visual impacts.

Specific tasks for assessment will include:

- Desk-top assessment to identify the view shed and potentially affected sensitive viewpoints;
- Assessment of view impact to be included in view analysis; and
- Preparation of photomontages and analysis of visual impacts from any potentially affected sensitive receptors.

The assessment will inform a Visual Impact Assessment to be included in the EIS.

7.13 Contamination and Waste Management

7.13.1 Existing environment

A search of the list of NSW contaminated sites notified to the EPA for Shoalhaven City Council LGA identified that there are no sites near Kangaroo Valley or close to the study area. The closest contaminated sites are in Nowra.

A search of the public contaminated land record of notices database was undertaken and revealed that two sites within the Shoalhaven City LGA are currently or have been formerly regulated under the *Contaminated Land Management Act 1997* (CLM Act). This search identified a former gasworks site as being currently regulated under the CLM Act and a service station as being formerly regulated under the CLM Act. Regulation of a Woolworths service station is recorded as currently 'being finalised'. Neither site is near the project area.

Based on an understanding of local geology there is a low risk of encountering geological units with naturally occurring asbestos within the study area.

7.13.2 Issues for consideration

Potential for contamination issues will be largely limited to construction of the project and unexpected discovery of contaminated materials associated with:

- The construction and maintenance of the existing surface pipeline;
- Disturbance of spoil from the original construction of the Shoalhaven Scheme;
- Historic agricultural practices;
- Asbestos containing material from old rural buildings or those used in the construction of the original Shoalhaven scheme; and
- Illegal dumping.

Chemicals associated with operation of the power station will be stored on-site, however, only incidental quantities of chemical contaminants will be utilised in the operation of the power station.

Construction of the project has the potential to generate waste materials including cleared vegetation, construction materials, domestic (employee related) wastes, and spoil. There is potential for the project to result in adverse impacts to the local environment if waste is not managed appropriately. Inappropriately managed waste may result in impacts to visual amenity, risks to health and safety of construction workers and members of the public, contribution to landfill, and pollution caused by release of chemical waste.

Excavation works required for construction of the power station caverns, the tunnels and vertical shaft could generate significant volumes of rock material. In addition to the noise, vibration and traffic issues discussed above, it will also require the identification and establishment of a long-term spoil emplacement sites. Options to re-use excavated material for the construction works would be investigated during detailed design.

Significant volumes of waste materials are not expected to be generated during operation of the project, beyond occasional minor waste streams associated with infrequent maintenance activities. These waste streams would be typical of maintenance wastes generated across the existing schemes network.

The project does not involve the removal of existing infrastructure. Cleared vegetation would be composted or re-used on the site to avoid the need for off-site waste disposal.

Minor volumes of waste will be generated during maintenance activities. These will be disposed of at appropriately licenced facilities.

7.13.3 Method of assessment

Background review and site inspection activities have been undertaken to determine contamination risks. This has identified that there is low potential for interaction with existing contamination, and that this would be able to be managed through the implementation of an unexpected finds protocol. Nevertheless, the EIS would document the outcomes of the background searches and site visit and describe:

- Land titles information, dangerous goods licences; site plans and information gained from discussions with Shoalhaven stakeholders, workers and local Council; correspondence with regulatory authorities;
- Site history including zoning, previous and present land use, building approvals and chronological list of site uses;
- Review of historical aerial photographs;
- Possible contaminant sources and potential off-site effects;
- Potential environmental risks;
- Any available reports or other information relating to the site and surrounding properties;
- Details relating to soils, acid sulfate soils, geology and hydrogeology; and
- Basis for assessment criteria and assumptions relating to the present and proposed land use option.

All relevant factors will be reported, and appropriate mitigation and management measures will be recommended.

The EIS would identify potential waste streams associated with construction of the project and would include standard management practices compliant with the *Waste Avoidance and Resource Recovery Act 2001* and other relevant policies and guidelines. A permanent spoil emplacement would be described and assessed as part of the EIS.

7.14 Socio-economic, Land Use and Property

7.14.1 Existing environment

The lower portion of the study area and the majority of the project footprint is located within the Shoalhaven Local Government Area (LGA). The surrounding region is comprised of multiple land zones, these include:

- SP2 Infrastructure (Water Supply System);
- RU2 Rural Landscape;
- E1 National Parks and Nature Reserves; and
- E2 Environmental Conservation.

Key protected environments surrounding the project include the Morton National Park, the Kangaroo River Nature Reserve and Lake Yarrunga.

The closest communities and townships in the vicinity of the lower study area are Barrengarry and Kangaroo Valley. These townships are located approximately 5.8 km and 6 km away from the closest point of the project.

In 2016, Barrengarry had a population of around 200 (ABS, 2018a), and Kangaroo Valley had an estimated resident population of 328 people (ABS, 2018b), with the population increasing during the summer months due to tourism. Apart from the Morton National Park and the Kangaroo River Nature Reserve, a key area used for recreational activities in Kangaroo Valley is the Bendeela Recreational Area. The Bendeela Recreational Area is a popular camping and recreation area that is set on the banks of Lake Yarrunga, approximately 1.2 km from the proposed inlet works. Accordingly, construction of the project is likely to have an impact on the Bendeela Recreational Area and other recreational facilities. Construction would also have a local economic benefit related to accommodation, restaurants and shops, and potentially other services in the region.

The access to the upper portion of the project, and Fitzroy Falls Reservoir, is located in the Wingecarribee Shire LGA. The surrounding region is comprised of multiple land zones, these include:

- B1 Neighbourhood Centre;
- SP2 Infrastructure (Water Supply System);
- E1 National Parks and Nature Reserves;
- E2 Environmental Conservation;
- E3 Environmental Management;
- R2 Low Density Residential;
- RE1 Public Recreation; and
- RU3 Forestry.

The closest townships to the upper portion of the study area include Fitzroy Falls, Wildes Meadow, Avoca and Burrawang approximately 4.8 km, 7.3 km, 8.3 km and 10.8 km from the access point respectively.

In 2016, Fitzroy Falls had an estimated population of 216 people (ABS, 2018c), Wildes Meadow had around 259 people (ABS, 2018d), Avoca had around 199 people (ABS, 2018e) and Burrawang had a population of approximately 207 people (ABS, 2018f).

Key tourist areas in the vicinity of the project include the Fitzroy Falls Look-out and the Fitzroy Falls Visitors Centre. Morton National Park offers a range of environmental, amenity and recreational values for local communities and visitors, including bushwalking, wildlife and birdwatching, information on the region's local Aboriginal culture and Aboriginal culture walks.

7.14.2 Issues for consideration

The potential for social impacts of the project are primarily limited to construction, the following impacts are anticipated:

- Construction operations that will be conducted near Bendeela Power Station may impact on access to the Bendeela Recreational Area;
- An influx of people in the construction workforce will be residing within the local and broader towns and villages for the duration of the construction period; and
- The operating regime of the power station may have implications for water based activities in the immediate vicinity of the outlet works on Lake Yarrunga and on Fitzroy Falls Reservoir.

Benefits of the operations of the project include:

- Improvement of security and continuity of energy supply to NSW and the NEM during periods of maximum hourly and daily demand;
- Creation of additional capacity of 235 MW in a heightened period with energy security being a critical issue for NSW and Australia; and
- Opportunities for local construction employment and additional spend to boost local business.

7.14.3 Method of assessment

A Socio-economic Impact Assessment will be undertaken in conjunction with community consultation to assess the impact of the construction of the project on local communities. The socio-economic implications of the operation of the project will also be addressed and will be included as part of the EIS.

7.15 Fire risk

7.15.1 Existing environment

Shoalhaven typically experiences mild temperatures with bush fire season generally occurring between September and March each year. Prevailing weather conditions associated with the bush fire season in the Shoalhaven area are north-westerly winds accompanied by high daytime temperatures and low relative humidity. There are also frequently dry lightning storms occurring during bush fire season (Shoalhaven BFMC, 1997).

The Shoalhaven Bush Fire Risk Management Plan (BFRMP) (1997) indicated an average of 600 bush fires per year, of which approximately 20 fires were considered to be 'major', requiring response by two or more fire authorities. The main sources of ignition in the Shoalhaven BFMC area included arson, accidental ignitions and lightning.

A significant portion of the proposed footprint and construction lay-down areas are surrounded by dry, densely vegetated bush land of the Morton National Park. As such the project area is considered to be a fire-prone location.

7.15.2 Issues for consideration

The potential for bushfire risk in the project study area is largely related to the construction of the project. The construction phase of the project has the potential to result in unplanned fires, creating risk to project staff as well as members of the public.

Key considerations include:

- Potential sources of ignition, most likely from equipment such as diesel generators, refuelling, magazine (explosives) storage and transport, LPG gas tanks and welding equipment;
- The upper portion of the project being surrounded by the Morton National Park, a densely vegetated, largely undisturbed bush land area. This area has limited access and is relatively isolated which poses significant challenges from a bushfire risk and management perspective; and
- Ensuring adequate construction standards and asset protection zones.

The implementation and management of bushfire protection measures will continue to be required for the operation phase of the project.

7.15.3 Method of assessment

The potential for bushfire hazard and risk impacts of the project will be investigated further in the EIS and through a Bushfire Risk Assessment, prepared in accordance with the relevant guidelines and standards.

8. Summary and Conclusions

Origin is the current operator of the Shoalhaven Scheme. Origin proposes to almost double the electricity generation capacity of the existing scheme with the Shoalhaven Hydro Expansion Project, which will provide approximately an additional 235MW of pumped storage generation capacity. The project has been declared Critical SSI and as such will be assessed under Division 5.2 of the EP&A Act.

This document provides a description of the project, existing information on environmental context and potential for environmental impacts and has been prepared in support of an application for the SEARs for the project. Once SEARs have been issued, Origin will prepare an EIS to address the SEARs. The EIS will be placed on public exhibition in accordance with Division 5.2 of the EP&A Act.

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Appendix A. Likelihood of occurrence

Likelihood of occurrence indicates how likely it is that a threatened species will be present within the project study area. Species are assigned a likelihood of occurrence from unlikely to high based on the following criteria:

Likelihood of Occurrence	Criteria
Unlikely	- Species highly restricted to certain geographical areas not within the proposal footprint - Species has specific habitat requirements that are not present in the study area
Low	Species that fit into one or more of the following criteria: - Have not been recorded previously in the study area/surrounds, and for which the study area is beyond the current distribution range - Use specific habitats or resources not present in the study area. - Are non-cryptic perennial flora species that were targeted by surveys and were not recorded.
Moderate	Species that fit into one or more of the following criteria: - Have infrequently been recorded previously in the study area/surrounds - Use specific habitats or resources present in the study area but in poor or modified condition - Are unlikely to maintain sedentary populations, however may seasonally use resources within the study area opportunistically or during migration - Are cryptic flowering species that were not seasonally targeted by surveys and have not been recorded.
High	Species that fit into one or more of the following criteria: - Have frequently been recorded previously in the study area/surrounds - Use habitat types or resources that are present in the study area in abundance and/or in good condition - Are known or likely to maintain resident populations surrounding the study area - Are known or likely to visit the site during regular seasonal movements or migration

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
*BAM P: Means species was listed in the BAM Predicted Species Report based on PCTs *BAM C: Means the species was listed in the BAM Candidate Species Report based on PCTs *# records: number of records from OEH BioNet Species Sightings Search						
Birds						
<i>Burhinus grallarius</i> Bush Stone-curlew	E	-	Open forests and woodlands with a sparse grassy ground layer and fallen timber.	BAM C	Low	Year round
<i>Calyptorhynchus lathami</i> Glossy Black-Cockatoo	V	-	The species is uncommon although widespread throughout suitable forest and woodland habitats, from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW, with a small population in the Riverina. An isolated population exists on Kangaroo Island, South Australia. Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of Sheoak occur. Black Sheoak (<i>Allocasuarina littoralis</i>) and Forest Sheoak (<i>A. torulosa</i>) are important foods. Inland populations feed on a wide range of Sheoaks, including Drooping Sheoak, <i>Allocasuarina diminuta</i> , and <i>A. gymnanthera</i> . Belah is also utilised and may be a critical food source for some populations. In the Riverina, birds are associated with hills and rocky rises supporting Drooping Sheoak, but also	BioNet Atlas 8 Records BAM P	High Foraging evidence in Sep site visit	Mar-Aug

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
			recorded in open woodlands dominated by Belah (<i>Casuarina cristata</i>).			
<i>Lathamus discolor</i> Swift Parrot	E	CE	Where eucalypts are flowering profusely or where there is abundant lerp infestations. Favour Swamp Mahogany (<i>Eucalyptus robusta</i>), Spotted Gum (<i>Corymbia maculata</i>), Red Ironbark (<i>E. sideroxylon</i>), and White Box (<i>E. albens</i>).	PMST BAM P C	Moderate	May-Aug
<i>Botaurus poiciloptilus</i> Australasian Bittern	E	E	Occurs from south-east Queensland to south-east South Australia, Tasmania and the south-west of Western Australia. Occurs in terrestrial freshwater wetlands and, rarely, estuarine habitats.	PMST BAM P	Low	
<i>Calidris ferruginea</i> Curlew Sandpiper	E	CE	The breeding range of the Curlew Sandpiper is mainly restricted to the Arctic of northern Siberia, including Yamal Peninsula east to Kolyuchiskaya Gulf, Chokotka Peninsula, and also New Siberian Island. Curlew Sandpipers mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in salt works and sewage farms.	PMST	Low	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
<i>Numenius madagascariensis</i> Eastern Curlew	-	CE	Within Australia, the Eastern Curlew has a primarily coastal distribution. The species is found in all states, particularly the north, east, and south-east regions including Tasmania. The Eastern Curlew is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sand flats, often with beds of seagrass.	PMST	Low	
<i>Grantiella picta</i> Painted Honeyeater	V	V	Nomadic and occurs at low densities throughout its range. The greatest concentrations of the bird and almost all breeding occurs on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter it is more likely to be found in the north of its distribution. Inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus <i>Amyema</i> .	PMST	Low	
<i>Rostratula australis</i> Australian Painted Snipe	E	E	Most records are from the south east, particularly the Murray Darling Basin, with scattered records across northern Australia and historical records from around the Perth region in Western Australia. Prefers fringes	PMST	Unlikely	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
			of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds.			
<i>Lophoictinia isura</i> Square-tailed Kite	V	-	In NSW it is often associated with ridge and gully forests dominated by <i>Eucalyptus longifolia</i> , <i>Corymbia maculata</i> , <i>E. elata</i> , or <i>E. smithii</i> . Individuals appear to occupy large hunting ranges of more than 100 km ² . They require large living trees for breeding, particularly near water with surrounding woodland /forest close by for foraging habitat. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs.	BioNet Atlas 1 Record BAM P C	High	Sep-Jan
<i>Hieraaetus morphnoides</i> Little Eagle	V	-	Occupies open eucalypt forest, woodland or open woodland. Sheoak or Acacia woodlands and riparian woodlands of interior NSW are also used.	BAM P C	High	Aug-Oct
<i>Haliaeetus leucogaster</i> White-bellied Sea-Eagle	V	M	Found in coastal habitats and terrestrial wetlands in tropical and temperate regions of mainland Australia and its offshore islands. Nests require living or dead mature trees within suitable vegetation within 1km of rivers, lakes, large dams or creeks, wetlands and coastlines	BAM P C	Moderate	Jul-Dec
<i>Ninox connivens</i>	V	-	Inhabits woodland and open forest, including fragmented remnants and partially	BAM P C	Moderate	May-Dec

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
Barking Owl			cleared farmland. Hunting can extend into closed forests and more open areas. Require hollows of large old trees, living eucalypts preferred.			
<i>Ninox strenua</i> Powerful Owl	V	-	Inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. Requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. Breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. Roosts by day in dense vegetation comprising species such as Turpentine <i>Syncarpia glomulifera</i> , Black She-oak <i>Allocasuarina littoralis</i> , Blackwood <i>Acacia melanoxylon</i> , Rough-barked Apple <i>Angophora floribunda</i> , Cherry Ballart <i>Exocarpus cupressiformis</i> and a number of eucalypt species.	BAM P C	Moderate	May-Aug
<i>Pandion cristatus</i> Eastern Osprey	V	M	Global distribution with four subspecies previously recognised throughout its range. Favour coastal areas, especially the mouths of large rivers, lagoons and lakes. Nests are made high in trees, usually within one kilometre of the sea.	BAM P C	Low	Apr-Nov
<i>Tyto novaehollandiae</i> Masked Owl	V	-	Dry eucalypt forests and woodland, typically prefers open forest with low shrub density. Requires old trees for roosting and nesting.	BAM P C	Moderate	May-Aug

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
<i>Tyto tenebricosa</i> Sooty Owl	V	-	Occupies the coast, coastal escarpment and eastern tablelands. Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as most eucalypt forests. Nests in very large tree hollows.	BAM P C	Moderate	Apr-Aug
<i>Circus assimilis</i> Spotted Harrier	V	-	The Spotted Harrier occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population. Occurs in grassy open woodland including Acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.	BAM P	Low	
<i>Anthochaera phrygia</i> Regent Honeyeater	CE	CE	Dry open forest in temperate woodlands, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Nest in horizontal branches or forks in tall mature eucalypts and Sheoaks.	PMST BAM P	Low	Sep-Dec
<i>Callocephalon fimbriatum</i> Gang-gang Cockatoo	V	-	In summer, tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In winter, lower altitudes in drier, more open	BioNet Atlas 12 records BAM P C	High	Oct-Jan

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
			eucalypt woodlands. Require tree hollows for breeding.			
<i>Petroica rodinogaster</i> Pink Robin	V	-	On the mainland, the species disperses north and west and into more open habitats in winter, regularly as far north as the ACT area, and sometimes being found as far north as the central coast of NSW. Inhabits rainforest and tall, open eucalypt forest, particularly in densely vegetated gullies.	BAM C	Low – The study area would be close to the northern fringes of the species' range.	Year round
<i>Petroica phoenicea</i> Flame Robin	V	-	The Flame Robin is endemic to south eastern Australia, and ranges from near the Queensland border to south east South Australia and also in Tasmania. In NSW, it breeds in upland areas and in winter, many birds move to the inland slopes and plains. It is likely that there are two separate populations in NSW, one in the Northern Tablelands, and another ranging from the Central to Southern Tablelands. Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes. Prefers clearings or areas with open understoreys. The groundlayer of the breeding habitat is dominated by native grasses and the shrub layer may be either sparse or dense. Occasionally occurs in temperate rainforest, and also in herbfields, heathlands, shrublands and sedgeland at high altitudes.	BAM P	Moderate	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
<i>Petroica boodang</i> Scarlet Robin	V	-	The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. This species lives in both mature and re-growth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps.	BioNet Atlas 4 records BAM P	Moderate	
<i>Artamus cyanopterus</i> Dusky Woodswallow	V	-	Dusky woodswallows are widespread in eastern, southern and south western Australia. The species occurs throughout most of New South Wales, but is sparsely scattered in, or largely absent from, much of the upper western region. Most breeding activity occurs on the western slopes of the Great Dividing Range.	BioNet Atlas 4 records	High	Year round
<i>Dasyornis brachypterus</i> Eastern Bristlebird	E	E	The distribution of the Eastern Bristlebird has contracted to three disjunct areas of south-eastern Australia. There are three main populations: Northern - southern Queensland/northern NSW, Central - Barren Ground NR, Budderoo NR, Woronora Plateau, Jervis Bay NP, Booderee NP and Beecroft Peninsula and Southern - Nadgee NR and Croajingalong NP in the vicinity of the NSW/Victorian border. The estimated population size is less than 2000 individuals occupying a total area of about 120 sq km. There are now only four populations in the southern	PMST BioNet Atlas 2 records	Low	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
			Queensland/northern NSW area with a total of 35 birds, compared to 15 years ago when 14 populations and 154 birds were recorded. This population once extended as far south as at least Dorrigo and has recently been identified as a separate ultrataxon (monoides) but further research is being undertaken to determine the validity of this. The remaining populations are the nominate ultrataxon (brachypterus) and once extended at least to what is now the Sydney urban area. The central population comprises an estimated 1600 birds, mainly from Barren Grounds Nature Reserve, Budderoo National Park and the Jervis Bay area. The southern population in Nadgee Nature Reserve and Howe's Flat is around 200 birds. Further surveys are required in parts of Ben Boyd National Park and Sydney Catchment Authority lands to determine whether further populations of the Eastern Bristlebird occur in these areas.			
<i>Daphoenositta chrysoptera</i> Varied Sittella	V	-	The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west. The Varied Sittella's population size in NSW is uncertain but is believed to have undergone a moderate reduction over the past several	BioNet Atlas 2 records BAM P	Moderate	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
			decades. Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy.			
<i>Stagonopleura guttata</i> Diamond Firetail	V	-	Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum (<i>Eucalyptus pauciflora</i>) Woodlands. Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities. Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland.	BioNet Atlas 1 record BAM P	Moderate	
<i>Pachycephala olivacea</i> Olive Whistler	V	-	The Olive Whistler inhabits the wet forests on the ranges of the east coast. It has a disjunct distribution in NSW chiefly occupying the beech forests around Barrington Tops and the MacPherson Ranges in the north and wet forests from Illawarra south to Victoria. In the south it is found inland to the Snowy Mountains and the Brindabella Range. Mostly inhabit wet forests above about 500 m. During the	BioNet Atlas 1 record BAM P	Moderate	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
			winter months they may move to lower altitudes.			
<i>Glossopsitta pusilla</i> Little Lorikeet	V	-	Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in apples (angophora sp.), paperbarks (melaleuca sp.) and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Isolated flowering trees in open country (e.g. paddocks, roadside remnants) and urban trees also help sustain viable populations of the species.	BAM P	Moderate	
<i>Neophema pulchella</i> Turquoise Parrot	V	-	Range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range. Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland.	BAM P	Moderate	
<i>Ptilinopus regina</i> Rose-crowned Fruit Dove	V	-	Coast and ranges of eastern NSW and Queensland, from Newcastle to Cape York. Vagrants are occasionally found further south to Victoria. Rose-crowned Fruit-doves occur mainly in sub-tropical and dry rainforest and occasionally in moist eucalypt forest and swamp forest, where fruit is plentiful.	BAM P	Low	
<i>Ptilinopus superbus</i> Superb Fruit-Dove	V	-	The Superb Fruit-dove occurs principally from north-eastern in Queensland to north-eastern NSW. Inhabits rainforest and similar	BAM P	Low	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
			closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms. It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees.			
<i>Ixobrychus flavicollis</i> Black Bittern	V	-	Occurs from south-east Queensland to south-east South Australia, Tasmania and the south-west of Western Australia. Occurs in terrestrial freshwater wetlands and, rarely, estuarine habitats.	BAM P	Low	
Mammals						
<i>Chalinolobus dwyeri</i> Large-eared Pied Bat	V	V	Forages over a broad range of open forest and woodland habitats. Cave roosting bat which favours sandstone escarpment habitats for roosting, in shallow overhands, crevices, and caves.	PMST BAM C	Moderate – Could occur along Fitzroy Falls escarpment	Sep-Mar
<i>Cercartetus nanus</i> Eastern Pygmy-possum	V	-	Found in a broad range of habitats from rainforest through to wet and dry sclerophyll forest and woodland to heath, but in most areas woodlands and heath appear to be preferred.	BAM C	Moderate – study area includes wet sclerophyll forests.	October-March
<i>Dasyurus maculatus</i> Spotted-tail Quoll	V	E	Wet and dry sclerophyll forests and rainforests, and adjacent open agricultural areas. Generally associated with large expansive areas of habitat to sustain territory size. Requires hollow-bearing trees, fallen logs, small caves, rock crevices,	PMST BioNet Atlas 6 records BAM P	Moderate	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
			boulder fields and rocky-cliff faces as den sites.			
<i>Miniopterus australis</i> Little Bentwing-bat	V	-	Eastern coast and ranges from Cape York to Wollongong. Roost in caves, tunnels, tree hollows, stormwater drains, culverts, bridges, and sometime buildings.	BAM P C	Moderate	Dec-Feb
<i>Miniopterus schreibersii oceanensis</i> Eastern Bentwing-bat	V	-	East and north-west coasts of Australia. Primarily roost in caves, but also use abandoned mines, stormwater tunnels, buildings and other man-made structures.	BioNet Atlas 7 records BAM P C	Moderate	Nov-Feb
<i>Mormopterus norfolkensis</i> Eastern Freetail-bat	V	-	Occur in dry sclerophyll forest and woodland east of the Great Dividing Range. Roosts mainly in tree hollows but will also roost under bark or in human-made structures.	BioNet Atlas 6 records BAM P	Moderate	
<i>Myotis macropus</i> Southern Myotis	V		Roosts close to water in caves, mine shafts, hollow-bearing trees, buildings, bridges, and in dense foliage. Forages over streams and ponds.	BioNet Atlas 2 records BAM C	Moderate	Nov-Mar
<i>Kerivoula papuensis</i> Golden-tipped Bat	V	-	The Golden-tipped Bat is distributed along the east coast of Australia in scattered locations from Cape York Peninsula in Queensland to south of Eden in southern NSW. It also occurs in New Guinea. Found in rainforest and adjacent wet and dry sclerophyll forest up to 1000m. Also recorded in tall open forest, Casuarina-	BAM P	Moderate	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
			dominated riparian forest and coastal Melaleuca forests. Roost mainly in rainforest gullies on small first- and second-order streams in usually abandoned hanging Yellow-throated Scrubwren and Brown Gerygone nests modified with an access hole on the underside. Bats may also roost under thick moss on tree trunks, in tree hollows, dense foliage and epiphytes.			
<i>Scoteanax rueppellii</i> Greater Broad-nosed Bat	V	-	Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings.	BAM P	Moderate	
<i>Saccolaimus flaviventris</i> Yellow-bellied Sheathtail Bat	V	-	Wide-ranging species found across northern and eastern Australia. Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows.	BAM P	Moderate	
<i>Phascolarctos cinereus</i> Koala	V	V	In NSW it mainly occurs on the central and north coasts with some populations in the west of the Great Dividing Range. Inhabit eucalypt woodlands and forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species.	PSMT BioNet Atlas 1 record BAM P C	High	Year round

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
<i>Pteropus poliocephalus</i> Grey-headed Flying-fox	V	V	Generally found within 200 km of the eastern coast. Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy.	PMST BioNet Atlas 4 records BAM P C		October-December
<i>Potorous tridactylus</i> Long-nosed Potoroo	V	V	The long-nosed potoroo is found on the south-eastern coast of Australia, from Queensland to eastern Victoria and Tasmania, including some of the Bass Strait islands. Inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature. The fruit-bodies of hypogeous (underground-fruited) fungi are a large component of the diet of the Long-nosed Potoroo. They also eat roots, tubers, insects and their larvae and other soft-bodied animals in the soil.	PSMT BioNet Atlas 8 records BAM P	Moderate	
<i>Pseudomys novaehollandiae</i> New Holland Mouse		V	Distribution is fragmented across all eastern states of Australia, where it inhabits open heath lands, open woodlands with heath understorey and vegetated sand dunes.	PMST	Low	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
<i>Isodon obesulus obesulus</i> Southern Brown Bandicoot (eastern)	E	E	This species prefers sandy soils with scrubby vegetation and/or areas with low ground cover that are burned from time to time. A mosaic of post fire vegetation is important for this species.	PMST	Low	Year round
<i>Petaurus norfolcensis</i> Squirrel Glider	V	-	Dispersed widely but sparsely through eastern Australia. Prefers mixed species stands with a shrub or Acacia midstorey.	BioNet Atlas 1 record BAM C	Moderate	Year round
<i>Petrogale penicillata</i> Brush-tailed Rock-wallaby	E	V	Range follows roughly the line of the Great Dividing Range. Occupies rocky escarpments, outcrops, and cliffs with a preference for complex structures. Browse on vegetation in and adjacent to rocky areas.	PMST BioNet Atlas 14 records BAM C	High	Year Round
<i>Sminthopsis leucopus</i> White-footed Dunnart			The White-footed Dunnart occurs in Tasmania and along the Victorian and southern NSW coast. The Shoalhaven area is the species' northern-most limit. It has not been recorded west of the coastal escarpment with the western-most record being from Coolangubra State Forest, approximately 10 km south-east of Bombala. In NSW, the species seems to favour vegetation communities with an open understorey structure (contrasting with populations in Victoria which apparently prefer dense shrub and ground layers). It is patchily distributed across these habitats and, where present, typically occurs at low	BAM C	Low	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
			densities. Breeding populations have been recorded in logged forest shortly after disturbance, but these usually do not persist as regeneration proceeds and a dense ground cover of vegetation establishes.			
<i>Petaurus australis</i> Yellow-bellied Glider	V	-	Found along the eastern coast to the western slopes of the Great Dividing Range, from southern Queensland to Victoria. Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south. Feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein. Extract sap by incising (or biting into) the trunks and branches of favoured food trees, often leaving a distinctive 'V'-shaped scar.	BioNet Atlas 12 records BAM P	Moderate	
<i>Falsistrellus tasmaniensis</i> Eastern False Pipistrelle	V	-	The Eastern False Pipistrelle is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania.	BioNet Atlas 1 record BAM P	Moderate	
<i>Petauroides volans</i> Greater Glider	-	V	The Greater Glider occurs in eucalypt forests and woodlands along the east coast of Australia from north east Queensland to	PMST	Moderate	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
			the Central Highlands of Victoria. This population of Greater Gliders on the south coast of NSW is bounded by the Moruya River to the north, Coila Lake to the south and the Princes Highway and cleared land exceeding 700 m in width to the west. Feeds exclusively on eucalypt leaves, buds, flowers and mistletoe. Shelter during the day in tree hollows and will use up to 18 hollows in their home range. Occupy a relatively small home range with an average size of 1 to 3 ha.	BioNet Atlas 2 records		
Reptiles & Amphibians						
<i>Hoplocephalus bungaroides</i> Broad-headed Snake	V	V	Shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. Shelters in hollows of large trees within 200m of escarpments in summer	BioNet Atlas 2 records BAM P C	Moderate	Aug-Sep
<i>Litoria aurea</i> Green and Golden Bell Frog	E	V	50 recorded locations in NSW, mostly coastal or near coastal. Large populations are located around metropolitan Sydney, Shoalhaven, and mid north coast.	PMST BAM C	Low	November-March
<i>Mixophyes balbus</i> Stuttering Frog	V	V	Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. Outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor.	PMST BAM C	Low – recent surveys have only found three locations south of Sydney	Sep-Mar

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
<i>Heleioporus australiacus</i> Giant Burrowing Frog	V	V	Northern population largely confined to the sandstone geology of the Sydney Basin and extending as far south as Ulladulla. Found in heath, woodland and open dry sclerophyll forest on a variety of soil types except those that are clay based.	PMST BAM C	Moderate	Sep-May
<i>Litoria littlejohni</i> Littlejohn's Tree Frog	V	V	Distribution includes the plateaus and eastern slopes of the Great Dividing Range. Breeds in the upper reaches of permanent streams and in perched swamps. Non-breeding habitat is heath based forests and woodlands where it shelters under leaf litter and low vegetation.	PMST BAM C	Low	July-Nov
<i>Pseudophryne australis</i> Red-crowned Toadlet	V	-	It has restricted distribution from Pokolbin to Nowra and west to Mt Victoria. Occurs in open forests and wet drainage lines below sandstone ridges that often have shale lenses or cappings in the Hawkesbury and Narrabeen Sandstones.	BAM C	Low	Year round
<i>Varanus rosenbergi</i> Rosenberg's Goanna	V	-	Rosenberg's Goanna occurs on the Sydney Sandstone in Wollemi National Park to the north-west of Sydney, in the Goulburn and ACT regions and near Cooma in the south. There are records from the South West Slopes near Khancoban and Tooma River. Also occurs in South Australia and Western Australia. Found in heath, open forest and woodland. Associated with termites, the mounds of which this species nests in;	BioNet Atlas 1 record BAM P	Moderate	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
			termite mounds are a critical habitat component. Shelters in hollow logs, rock crevices and in burrows, which they may dig for themselves, or they may use other species' burrows, such as rabbit warrens.			
Plants						
<i>Haloragis exalata</i> subsp. <i>exalata</i> Square Raspwort / Wingless Raspwort	V	V	Four scattered localities in eastern NSW. Requires protected and shaded damp situations in riparian habitats.	PMST BAM C	Unlikely – closest known location in Wollongong	Year round
<i>Cryptostylis hunteriana</i> Leafless Tongue Orchid	V	V	Larger populations typically occur in woodland dominated by Scribbly Gum (<i>Eucalyptus sclerophylla</i>), Silvertop Ash (<i>E. sieberi</i>), Red Bloodwood (<i>Corymbia gummifera</i>) and Black Sheoak (<i>Allocasuarina littoralis</i>); appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (<i>C. subulata</i>) and the Tartan Tongue Orchid (<i>C. erecta</i>).	PSMT BioNet Atlas 1 record BAM C	Moderate	November-February
<i>Cynanchum elegans</i> White-flowered Wax Plant	E	E	Occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest, Coastal Tea-tree (<i>Leptospermum laevigatum</i>) – Coastal Banksia (<i>Banksia integrifolia</i> subsp. <i>integrifolia</i>) coastal scrub; Forest Red Gum (<i>Eucalyptus tereticornis</i>) aligned open forest and woodland; Spotted Gum (<i>Corymbia maculata</i>) aligned open forest and	PMST BAM C	Moderate – potential in open forest and woodland with Forest Gum and any rainforest edges	Year round

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
			woodland; and Bracelet Honey myrtle (<i>Melaleuca armillaris</i>) scrub to open scrub.			
<i>Daphnandra johnsonii</i> Illawarra Socketwood	E	E	Restricted to the Illawarra region where it has been recorded from the local government areas of Shoalhaven, Kiama, Shellharbour and Wollongong. Occupies the rocky hillsides and gullies of the Illawarra lowlands, occasionally extending onto the upper escarpment slopes. Associated vegetation includes rainforest and moist eucalypt forest.	BAM C	Moderate – Could occur along the Fitzroy Falls escarpment	Year round
<i>Irenepharsus trypherus</i> Illawarra Irene	E	E	Prefers to grow on steep rocky slopes near cliff lines and ridge tops that extend south and east of the Illawarra escarpment. Has also been recorded in deep sandstone gorges along the Shoalhaven River.	PMST BioNet Atlas 15 records BAM C	High	
<i>Chorizema parviflorum</i> - endangered population Chorizema parviflorum Benth. in the Wollongong and Shellharbour Local Government Areas	EP	-	Endangered population recorded between Austinmer and Albion Park in local government areas of Wollongong and Shellharbour. Occupy woodland dominated by Forest Red Gum (<i>Eucalyptus tereticornis</i>) and/or Woollybutt (<i>E. longifolia</i>).	BAM C	Unlikely – this is a local Wollongong population only	
<i>Lespedeza juncea subsp. sericea</i> - endangered population Lespedeza juncea subsp. sericea in the Wollongong Local Government Area	EP	-	Just south of Dapto in the Wollongong local government area. This population is distinct from the other (non-endangered) populations of the species in NSW. Known from its singular roadside population of approximately 200 plants, located in a small	BAM C	Unlikely – This is a local Wollongong population only	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
			strip of open forest dominated by <i>Eucalyptus tereticornis</i> (Forest Red Gum), <i>E. longifolia</i> (Woollybutt), and <i>Melaleuca decora</i> (White Feather Honey Myrtle), on Budgong Sandstone.			
<i>Pimelea curviflora</i> var. <i>curviflora</i> Pimelea curviflora var. <i>curviflora</i>	V	V	Confined to the coastal area of Sydney between northern Sydney in the south and Maroota in the north-west. Former range extended south to the Parramatta River and Port Jackson region including Five Dock, Bellevue Hill and Manly. Occurs on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands.	BAM C	Low	Year round
<i>Pimelea spicata</i> Spiked Rice-flower	E	E	Broad distribution in western Sydney, occurring on the Cumberland Plain (Narellan, Marayong, Prospect Reservoir areas). Another smaller population is recorded in districts (Landsdowne to Shellharbour to northern Kiama) Illawarra. It grows on well-structured clay soils. On the inland Cumberland Plain sites it is associated with Grey Box and Ironbark. In the coastal Illawarra it occurs commonly in Coastal Banksia open woodland with a more well developed shrub and grass understorey.	PMST BAM C	Low	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
<i>Pterostylis gibbosa</i> Illawarra Greenhood	E	E	Known from a small number of populations in the Hunter region (Milbrodale), the Illawarra region (Albion Park and Yallah) and the Shoalhaven region (near Nowra). It is apparently extinct in western Sydney which is the area where it was first collected (1803). All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage. In the Hunter region, the species grows in open woodland dominated by Narrow-leaved Ironbark (<i>Eucalyptus crebra</i>), Forest Red Gum (<i>Eucalyptus tereticornis</i>) and Black Cypress Pine (<i>Callitris endlicheri</i>).	PMST BAM C	Low	Jun-Sep
<i>Solanum celatum</i> Solanum celatum	E	-	This shrub is restricted to an area from Wollongong to south of Nowra and west to Bungonia. Its habitat includes rainforest clearings or wet sclerophyll forest and is generally found in disturbed margins and clearings.	BioNet Atlas 10 records BAM C	High	Sep-Nov
<i>Syzygium paniculatum</i> Magenta Lilly Pilly	E	V	The Magenta Lilly Pilly is found only in NSW, in a narrow, linear coastal strip from Upper Lansdowne to Conjola State Forest. On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery	PMST BAM C	Low	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
			rainforests and remnant littoral rainforest communities.			
<i>Zieria granulata</i> Illawarra Zieria	E	E	Illawarra Zieria is a bushy shrubs restricted to the Illawarra region primarily in coastal lowlands. It typically occupies dry ridges and rocky outcrops on shallow volcanic soils and less frequently found on moist slopes of the Illawarra escarpment. It grows in association with vegetation comprising Melaleuca armillaris scrub and Eucalyptus tereticornis woodland and rainforest margins.	BAM C	Low	Year round
<i>Hibbertia stricta</i> subsp. <i>furcatula</i> Hibbertia stricta subsp. <i>furcatula</i>	E	-	Known to occur in two populations, one in the southern outskirts of Sydney, and one near Nowra on the mid-South Coast of NSW. Habitat of the Southern Sydney population is broadly dry eucalypt forest and woodland. This population appears to occur mainly on upper slopes and above the Woronora River gorge escarpment, at or near the interface between the Lucas Heights soil landscape and Hawkesbury sandstone. The species usually grows in 'gravelly loam or clay soil in heath under open woodland'. Habitat of the South Coast population is poorly recorded, but appears to be dry sclerophyll forest or woodland associations in sandy soils over sandstone.	BAM C	Low	Oct-Mar

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
<i>Acacia bynoeana</i> Bynoe's Wattle	E	V	Found in central eastern NSW, from the Hunter District south to the Southern Highlands and west to the Blue Mountains. It has recently been found in the Colymea and Parma Creek areas west of Nowra. Occurs in heath or dry sclerophyll forest on sandy soils. Seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches. Associated overstorey species include Red Bloodwood (<i>Corymbia gummifera</i>), Scribbly Gum (<i>Eucalyptus haemastoma</i>), Drooping Red Gum (<i>E. parramattensis</i>), Old Man Banksia (<i>Banksia serrata</i>) and Small-leaved Apple (<i>Angophora bakeri</i>).	PSMT	Moderate	Sep-Mar
<i>Boronia deanei</i>	V	V	There are scattered populations of Deane's Boronia between the far south-east of NSW and the Blue Mountains (including the upper Kangaroo River near Carrington Falls, the Endrick River near Nerriga and Nalbaugh Plateau), mainly in conservation reserves. Wildfires have depleted some populations.	PMST	Low	
<i>Asterolasia elegans</i>	E	E	Occurs north of Sydney, in the Baulkham Hills, Hawkesbury and Hornsby local government areas. Also likely to occur in the western part of Gosford local government area. Known from only seven populations, only one of which is wholly	PMST	Unlikely – Study area not in species known range	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
			within a conservation reserve. Occurs on Hawkesbury sandstone. Found in sheltered forests on mid- to lower slopes and valleys, e.g. in or adjacent to gullies which support sheltered forest. The canopy at known sites includes Turpentine (<i>Syncarpia glomulifera</i> subsp. <i>glomulifera</i>), Smooth-barked Apple (<i>Angophora costata</i>), Sydney Peppermint (<i>Eucalyptus piperita</i>), Forest Oak (<i>Allocasuarina torulosa</i>) and Christmas Bush (<i>Ceratopetalum gummiferum</i>).			
<i>Caladenia tessellate</i> Thick-lipped Spider-orchid	E	V	Known from the Sydney area (old records), Wyong, Ulladulla and Braidwood in NSW. Populations in Kiama and Queanbeyan are presumed extinct. Generally found in grassy sclerophyll woodland on clay loam or sandy soils, though the population near Braidwood is in low woodland with stony soil.	PMST	Low	
<i>Eucalyptus macarthurii</i> Camden Woollybutt	V	E	Has a moderately restricted distribution. It is currently recorded from the Moss Vale District to Kanangra Boyd National Park. In the Southern Highlands it occurs mainly on private land, often as isolated individuals in, or on the edges, of paddocks. Isolated stands occur in the north west part of the range on the Boyd Plateau. The only known record in the conservation estate is within Kanangra Boyd National Park	PMST	Unlikely	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
<i>Genoplesium baueri</i> Yellow Gnat-orchid	E	E	Recorded from locations between Nowra and Pittwater and may occur as far north as Port Stephens. About half the records were made before 1960 with most of the older records being from Sydney suburbs including Asquith, Cowan, Gladesville, Longueville and Wahroonga. No collections have been made from those sites in recent years. The species has been recorded at locations now likely to be within the several conservation reserves including Berowra Valley Regional Park, Royal National Park and Lane Cove National Park. May occur in the Woronora, O'Hares, Metropolitan and Warragamba Catchments. Found in sparse sclerophyll forest and moss gardens over sandstone	PSMT BAM C	Low	Feb-Mar
<i>Melaleuca biconvexa</i> Biconvex Paperbark	V	V	Found only in NSW, with scattered and dispersed populations found in the Jervis Bay area in the south and the Gosford-Wyong area in the north. Generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects.	PMST	Unlikely – outside of range	
<i>Melaleuca deanei</i> Deane's Melaleuca	V	V	Deane's Paperbark occurs in two distinct areas, in the Ku-ring-gai, Berowra, Holsworthy and Wedderburn areas, and there are also more isolated occurrences at Springwood, Wollemi National Park, Yalwal	PMST	Low – Just on fringes of known range	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
			and the Central Coast areas. The species grows in heath on sandstone			
<i>Pelargonium</i> sp. <i>Striatellum</i> Omeo Stork's-bill	E	E	Known from only 3 locations in NSW, with two on lake-beds on the basalt plains of the Monaro and one at Lake Bathurst. A population at a fourth known site on the Monaro has not been seen in recent years. The only other known population is at Lake Omeo, Victoria. It occurs at altitudes between 680 to 1030 m. It is known to occur in the local government areas of Goulburn-Mulwaree, Cooma-Monaro, and Snowy River, but may occur in other areas with suitable habitat; these may include Bombala, Eurobodalla, Palerang, Tumbarumba, Tumut, Upper Lachlan, and Yass Valley local government areas. It has a narrow habitat that is usually just above the high-water level of irregularly inundated or ephemeral lakes, in the transition zone between surrounding grasslands or pasture and the wetland or aquatic communities. It sometimes colonises exposed lake beds during dry periods.	PMST	Unlikely	
<i>Persoonia glaucescens</i> Mittagong Geebung	E	V	The Mittagong Geebung's historical distribution places the northern and eastern limit at Couridjah (Thirlmere Lakes), the southern limit at Fitzroy Falls and the western limit at High Range. However, recent surveys have indicated that the	PMST	Unlikely – outside of known range	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
			species no longer extends to Fitzroy Falls or Kangaloon and that the present southern limit is near Berrima. The Mittagong Geebung grows in woodland to dry sclerophyll forest on clayey and gravely laterite. The preferred topography is ridge-tops, plateaux and upper slopes.			
<i>Prasophyllum fuscum</i> Slaty Leek-orchid	CE	V	Grows in moist heath, often along seepage lines. The known population grows in moist sandy soil over sandstone amongst sedges and grasses in an area that appears to be regularly slashed by the local council.	PMST	Unlikely – outside of known range	
<i>Pterostylis pulchella</i> Waterfall greenhood	V	V	The Waterfall Greenhood is found only at Fitzroy Falls, Belmore Falls, upper Bundanoon Creek (Meryla) and Minnamurra Falls. Found on cliff faces close to waterfalls and creek banks and mossy rocks alongside running water.	PMST	Moderate	Feb-May (flowering)
<i>Thelymitra kangaloonica</i> Kangaloon Sun Orchid	CE	CE	Only known to occur on the southern tablelands of NSW in the Moss Vale / Kangaloon / Fitzroy Falls area at 550-700 m above sea level. It is known to occur at three swamps that are above the Kangaloon Aquifer. It is found in swamps in sedgeland over grey silty grey loam soils	PMST	Low – No known swampy areas within study area	
<i>Thesium australe</i> Austral Toadflax	V	V	Found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland	PMST	Low	

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
			and in eastern Asia. Occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast. Often found in association with Kangaroo Grass (<i>Themeda australis</i>).			
<i>Triplarina nowraensis</i> Nowra Heath-myrtle	E	E	There are five known populations of Nowra Heath Myrtle. Three of these form a cluster to the immediate west of Nowra. A fourth, much smaller population is found 18km south-west of Nowra in the Boolijong Creek Valley. The fifth population is located north of the Shoalhaven River on the plateau above Bundanon.	PMST BAM C	Low	Year round
<i>Xerochrysum palustre</i> Swamp Everlasting	V	V	Found in Kosciuszko National Park and the eastern escarpment south of Badja. Also found in eastern Victoria. Grows in swamps and bogs which are often dominated by heaths. Also grows at the edges of bog margins on peaty soils with a cover of shrubs or grasses.	PMST	Unlikely	
<i>Pomaderrus cotoneaster</i> Cotoneaster Pomaderris	E	E	Cotoneaster Pomaderris has a very disjunct distribution, being known from the Nungatta area, northern Kosciuszko National Park (near Tumut), the Tantawangalo area in South-East Forests National Park and adjoining freehold land, Badgery's Lookout near Tallong, Bungonia State Conservation Area, the Yerranderie area, Kanangra-Boyd National Park, the Canyonleigh area and	BioNet Atlas 2 records	Moderate	Oct-Nov

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
			Ettrema Gorge in Morton National Park. The species has also been recorded along the Genoa River in Victoria			
<i>Eucalyptus langleyi</i> Albatross Mallee	V	-	The main occurrence of the Albatross Mallee is to the south-west of Nowra as far as Yarramunmun Creek. A very small population is found to the north of the Shoalhaven River in the Bomaderry Creek Regional Park.	BAM C	Low/Moderate?	Year round
<i>Callistemon linearifolius</i> Netted bottle brush	V	-	Recorded from the Georges River to Hawkesbury River in the Sydney area, and north to the Nelson Bay area of NSW. Recorded in 2000 at Coalcliff in the northern Illawarra. For the Sydney area, recent records are limited to the Hornsby Plateau area near the Hawkesbury River. The species was more widespread in the past, and there are currently only 5-6 populations remaining from the 22 populations historically recorded in the Sydney area. Three of the remaining populations are reserved in Ku-ring-gai Chase National Park, Lion Island Nature Reserve and Spectacle Island Nature Reserve. The species has also been recorded from Yengo National Park.	BioNet Atlas 1 record	Low	
<i>Gossia acmenoides</i>	EP	-	Gossia acmenoides grows in dry rainforest, as well as in subtropical rainforest, on the ranges and coastal plain of eastern	BAM C	Low	Not specified

Species	BC Act	EPBC Act	Distribution and Habitat	Data Source *see notes on page 1	Likelihood of Occurrence	Targeted Survey Timing
Gossia acmenoides population in the Sydney Basin Bioregion south of the Georges River			Australia from the Illawarra (in the south) to Queensland. The population of Gossia acmenoides in the Sydney Basin Bioregion south of the Georges River is found in the local government areas of Wollongong, Shellharbour and Kiama. There are currently about 30 sites where G. acmenoides is found, often as single individual plants or as a small group of up to four individuals. There are estimated to be less than 100 mature G. acmenoides plants in the population.			